URBAN TRANSPORTATION
INSTITUTIONAL GRANT
RESEARCH AND TRAINING PROPOSAL

file

MAR 28 1979

URBAN TRANSPORTATION INSTITUTIONAL GRANT

RESEARCH AND TRAINING PROPOSAL

1. Name of Institution: University of Minnesota
   Address of Institution: Minneapolis, Minnesota 55455

2. Name and Title of Authorized Official of Institution: C. S. Plank, Controller

3. Grant to: Same

4. Project Director: Dr. Daniel L. Gerlough
   Title and Academic Address: Professor of Transportation Engineering
   Coordinator, Program in Urban Transportation
   175 Experimental Engineering Building
   Telephone: Office Number (612) 373-5875
   Home Number (612) 646-5401

5. Total Support Requested from UMTA (To Nearest $100): $320,000

6. Proposed Duration of Grant: 36 months

7. Funding Profile:
   Nominal Annual Rate: $110,000
   Institutional Receipts Expected by Year:
   1st: $190,000
   2nd:
   3rd:
   Was Formula Used for Receipts: No

8. Date of Submittal: March 10, 1970

9. Are funds for any part of the project proposed herein being requested in any other proposal to UMTA, DOT, or any other Federal Agency? No

Daniel L. Gerlough
Signature of Director Named in "4" above — Phone: (612) 373-5875

C/Plank
Signature of Chief Executive Officer Named in "2" above — Phone: (612) 373-2058

ABSTRACT

The University of Minnesota proposes for Federal support under Section 11 of the Urban Mass Transportation Act of 1964 a program of research and training in urban transportation. This activity will be administered by the Program in Urban Transportation which is a part of the Center for Urban and Regional Affairs at the University. This Program is broadly interdisciplinary in nature.

Items proposed for Federal support include fellowships for graduate students, several research projects (which will indirectly provide a learning experience and financial support for a number of students), a library collection of urban transportation literature, an interdisciplinary core seminar, and a workshop in interdisciplinary design.

The proposed Federal support for 1970 - 71 is $110,000 of which it is proposed that $10,000 be unused funds from a 1969 - 70 grant under Section 11. For 1970 - 71 the University expects to contribute $37,954 to this activity, and $3500 will be sought from other sources.

Proposed funding for later years is detailed herein.

INTRODUCTION

The University of Minnesota, having a firm belief in the importance of urban transportation to today's society, in 1967 created a professorship in Transportation Engineering. This was followed in 1968 by the organization of an interdisciplinary Prcgram in Urban Transportation under the Center for Urban and Regional Affairs. In 1969 the Program in Urban Transportation received a one-year Federal grant to assist the activities of the formative years by providing funds for fellowships, research, and training.

This document constitutes a proposal to the U.S. Department of Transportation for another grant under Section 11 of the Urban Mass Transportation Act of 1964. The amount requested for the year 1970-71 is $110,000 including $10,000 to be carried over from the 1969-70 grant.

THE UNIVERSITY OF MINNESOTA

The University of Minnesota is the state university and the state's land grant college. Programs are offered on four campuses, but most of the colleges and schools are located on the Twin Cities campus. The University is proud of the fact that it was chartered by the territory of Minnesota seven years before Minnesota became a state. Today the University has grown into a major center of education, creative scholarship, research and service. It is one of the largest universities in the United States with a 1968 - 1969 enrollment of more than 47,000 full-time students in its degree granting colleges and schools. At its 1969 session the State Legislature was asked to provide operating funds of $93.1 million for 1969 - 70. To this the Regents proposed to add $29.6 million from tuition and other sources, making a total operating budget of $122.7 for the fiscal year. Additional funds were provided for new facilities. Like any university, Minnesota has the traditional task of educating its students and fostering research and scholarship. As a state university, it has the added responsibility of serving the people of the state.

Since its founding, the University has awarded more than 200,000 degrees, each one in recognition of the successful completion of an exacting academic program. The University of Minnesota is among the top ten universities in the United States in the number of Ph.D. degrees granted annually. Wherever you find Minnesota graduates you will find a

continuous record of achievement and service--in science and technology, medicine and education, government and business--in almost every branch of human endeavor.

Research and scholarship are essential to teaching and essential to training students. Applied research brings creative men, industry, and money into Minnesota. In a broader context, research contributes to the world's fight against ignorance, hunger, disease, and poverty.

The range of research at the University is vast--from archeology to zoology, from open-heart surgery to travel in space.

Agricultural researchers have pioneered in developing new farming methods and new crop varieties. Minnesota's medical scientists have made revolutionary progress in diagnosing and treating cancer, heart disease, ulcers, brucellosis, and nutritional ailments, as well as mental illness, and in solving problems related to organ transplantation.

The Institute of Technology has made contributions in many fields. Metallurgical and mining engineers have helped the mining industry through their studies on taconite. Electrical engineers have fostered the booming electronics industry, now the fourth largest industry in Minnesota.

Basic research also is pursued at the University. In fields with applications that may only dimly be guessed at, researchers are exploring the mysteries of the atoms and of galaxies, the secrets within chromosomes and cultures.

Research, teaching and service are linked, as the University shares its knowledge and resources with the citizens of the state. Thousands of Minnesotans have had help from the county agricultural, home, or 4-H agents of the Agricultural Extension Service. Thousands have come to know the University's medical center as a place of hope and healing. The University Hospitals dramatically show how teaching medical students and research in medical science work together to benefit patients. The Bureau of Educational Research studies local school systems and offers advice on how they can be developed or improved. The Minnesota Geological Survey contributes information about mineral resources.

The University also offers teaching services to thousands of Minnesotans who are not enrolled in its regular full-time programs. Some register in the General Extension Division for evening or independent study (correspondence) courses. Some have come back to school part-time after many years to catch up on the new worlds of knowledge they had been missing. The Department of Off-Campus Classes offers courses tailored to the needs of the various off-campus groups.

The following is a listing of the academic deivisions of the University. Each of the divisions is composed of several departments.

Institute of Agriculture

College of Agriculture, Forestry, and Home Economics

School of Forestry
School of Home Economics
Schools of Agriculture (subcollegiate)
Technical Institute, Crookston
Agricultural Experiment Station
Agricultural Extension Service

Agricultural Short Courses
International Agricultural Programs

College of Biological Sciences

School of Business Administration

School of Dentistry

College of Education
School of Physical Education
University High School

General College

General Extension Division

Graduate School

Office of International Programs

Law School

College of Liberal Arts
School of Journalism and Mass Communication
Library School
School of Social Work

College of Medical Sciences
University Hospitals
Medical School
School of Nursing
School of Public Health

College of Pharmacy

Summer Session

Institute of Technology
School of Architecture
School of Chemistry
School of Earth Sciences
College of Engineering
School of Mineral and Metallurgical Engineering
School of Physics and Astronomy
School of Mathematics

University College

College of Veterinary Medicine

University of Minnesota, Duluth

University of Minnesota, Morris

Department of Law Enforcement Science

Departments of Aerospace Studies, Military Science, and Naval Science (Air Force, Army, and Navy ROTC)

Department of Concerts and Lectures

Center for Urban and Regional Affairs

Bureau of Institutional Research

Council on Liberal Education

University Libraries

James Ford Bell Museum of Natural History

University Press

Space Science Center

University Computer Services

PROGRAM IN TRANSPORTATION

Background

Because of its location within a major urban complex, center of regional business and finance, and seat of state government, the University of Minnesota has a long history of close and fruitful relationships between faculty, students and community. Consequently, use of the urban laboratory has developed intensively yet quite naturally over a long period in the Minnesota faculty. An important part of this development has been concerned with transportation. The University has recently moved to fill important gaps and strengthen its offerings in urban transportation. Meanwhile, faculty from diverse centers of action in this field have joined to form a coordinate traning program.

The objectives of the program include:

1. Bringing together of those faculty members now actively concerned with various aspects of urban transportation to form a synergism.
2. Provision of a medium whereby faculty members not active in the field of urban transportation but who have an interest in the field, will be able to make contributions to the field.
3. Provision of a medium whereby the faculty and members of local governmental agencies can interact to improve urban transportation.
4. Provision of a medium for the sponsorship of interdisciplinary research.
5. Transmission to students a body of knowledge which will enable them to make important contributions to the field of urban transportation.

Historical Development

In the fall of 1968 informal sessions between representatives of several departments interested in the Urban Transportation problem brought out the fact that there is much common interest and a desire to conduct indisciplinary activities on a formalized and continuing basis. It further appeared that the newly established Center for Urban and Regional Affairs within the University would make a logical home for such an interdisciplinary activity. A meeting was held with about 25 people representing many departments to explain the objectives of such a program and to solicit statements of interest in participation. Thereafter those indicating an interest in participation in a Program in Urban Transportation were invited to contribute proposals on research projects, to serve as members of committees, serve as advisors of students, to prepare seminar sessions, etc. An Administrative Committee was formed to make important policy decisions and a Coordinator was named. The initial activity of this Administrative Committee and Coordinator was the preparation of a proposal to the Department of Transportation and the Department of Housing and Urban Development under guidelines dated September, 1968. This proposal resulted in a grant for 1969 - 70 of $150,000.

Activities During 1969 - 70

During the academic year 1969 - 70, the program in Urban Transportation has supported 6 students through fellowships and it supported 8 students as research assistants. This information is listed in Appendix A.

During the year several departments have added new courses to aid the study of Urban Transportation problems. They are as follows:

Geography 172:	Transportation Geography (Assoc. Prof. R.B. Adams)
Mechanical Engineering 290:	Readings in Urban Transportation Technology (Assoc. Prof. J.E. Anderson)
Psychology 11A:	Engineering Psychology (Adjunct Assoc. Prof. A. Macek)

A core seminar has been organized to provide a medium of discussion for students faculty representatives of public agencies, and representatives of industry. Appendix B contains a list of the seminars speakers and their subjects for the Fall and Winter quarters. Also included is a summary of the seminar attendance from September 30, 1969 thru March 3, 1970. These seminars have had a significant effect in broadening the viewpoints of the participants. (See letter in Appendix D).

Organization

The chart on the next page indicates the organizational framework of the Program in Urban Transportation.

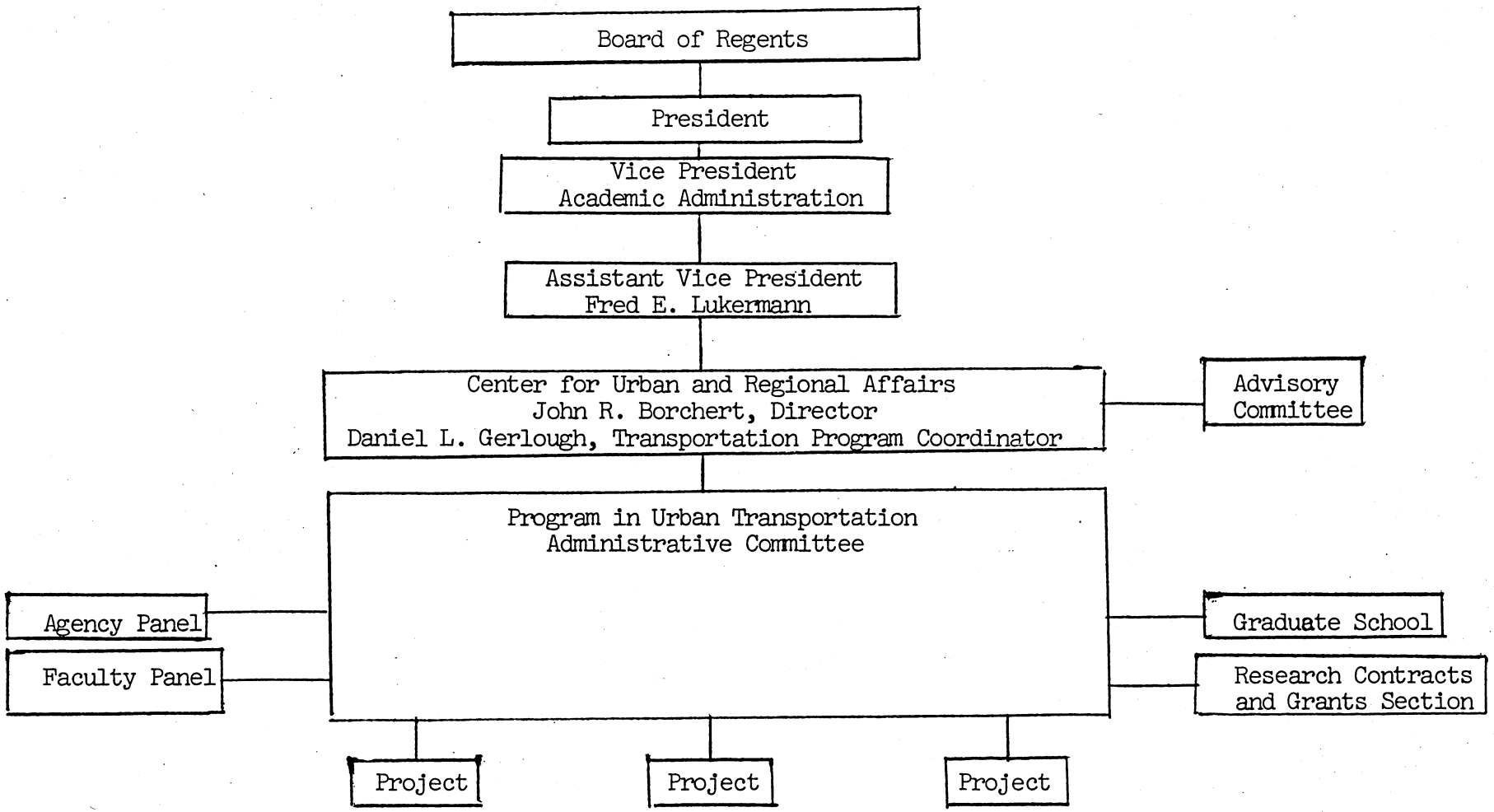
The Program in Urban is an arm of the Center for Urban and Regional Affairs.

An Advisory Committee of administrative personnel provides advice on long-range objectives of the Program and is available to assist in allocation of resources etc.

Operational matters, including selection of fellowship students, etc. are referred to an Administrative Committee.

Day-to-day matters and the execution of policies are handled by the Coordinator (Project Director) who serves as Chairman of the Administrative Committee and Convener of the other committees and panels.

ORGANIZATIONAL FRAMEWORK



A Faculty Panel is available to advise the Administrative Committee covering all aspects of the program. In addition, the Panel constitutes a pool from which advisors to students may be drawn. Membership on the panel is quite broad, consisting of all faculty members who express a desire to serve.

The Agency Panel assists the Administrative Committee by providing advice on needs for new courses (both regular curriculum and short courses), needs for research, sources of internships and other appropriate matters. Appendix C consists of a letter summarizing some views of this panel concerning research.

Certain specialized administrative functions are carried out by the Graduate School and by the Research Contracts and Grants Section.

Center for Urban and Regional Affairs

The Center for Urban and Regional Affairs was recently established by the Board of Regents to coordinate and facilitate urban and regional research, training and service within the University. The Center for Urban and Regional Affairs is administratively directly responsible to the Office of the Vice-President for Academic Administration. The Center is directed by Professor John R. Borchert, who has carried out and directed urban transportation research and has served as a consultant to various public transportation agencies. The Center has two offices: an Office of Research and an Office of Community Programs, which report to the director of the Center. Under these two offices, numerous new urban programs have been developed at the University. Both the Office of Research and the Office of Community Programs are staffed by faculty

members, each of whom holds a joint appointment in a line department and in the Center for Urban and Regional Affairs.

To facilitate the development and management of the proposed University of Minnesota Program in Urban Transportation, Daniel L. Gerlough, Professor of Transportation Engineering, has assumed a joint appointment with the Center's Office of Research. His primary duties as a coordinator within the Center are to work with the urban transportation training and research program. Both Professor Gerlough and Professor Borchert sit on the Administrative Committee, which manages the Program in Urban Transportation.

Advisory Committee

The following administrative personnel constitute the Advisory Committee:

John R. Borchert
Director, Center for Urban and Regional Affairs

John E. Brandl
Director, School of Public Affairs

Donald V. Harper
Chairman, Department of Management, Production and Transportation, School of Business Administration

Warren E. Ibele
Associate Dean, Graduate School

Fred E. Lukermann
Assistant Vice President
Academic Administration

Richard A. Swalin
Associate Dean, Institute of Technology

John G. Turnbull
Associate Dean, College of Liberal Arts

Sub-committee on Research: W.E. Ibele, R.A. Swalin, J.G. Turnbull

Advisor on Fellowship Matters: E.W. McDiarmid
Director
Graduate School Fellowship Office

Administrative Committee

Currently the members of the Administrative Committee are:

Chairman and Program Coordinator:
Daniel L. Gerlough, Professor of Transportation Engineering

John E. Anderson, Associate Professor of Mechanical Engineering

John R. Borchert, Professsor of Geography and Director of the Center for Urban and Regional Affairs

Donald V. Harper, Professor and Chairman of the Management, Production and Transportation Department, School of Business Administration

Matthew J. Huber, Associate Professor of Civil Engineering

Warren E. Ibele, Associate Dean of the Graduate School and Professor of Mechanical Engineering

K. S. P. Kumar, Associate Professor of Electrical Engineering

Herbert Mohring, Professor of Economics

Thomas M. Scott, Associate Professor of Political Science

Biographic sketches of these men are included in the section in this proposal on Academic Personnel.

Agency Panel

Membership of the Agency Advisory Panel currently includes the following agencies:

Metropolitan Council

Minnesota Highway Department

State Planning Agency

Twin Cities Metropolitan Transit Commission

Faculty Panel

The following professors are currently members of the Faculty Panel:

Name	Department
R. B. Adams	Geography
G. N. Anderew	Management Sciences
D. Braslau	Geology and Geophysics
J. E. Anderson	Mechanical Engineering
T. R. Anderson	Sociology
R. G. Bond	Environmental Health
J. R. Borchert	Geography
R. Clemence	Architecture
P. W. Fox	Psychology
D. A. Frohrib	Mechanical Engineering
D. L. Gerlough	Civil Engineering
N. A. Glaskowsky	Production, Management and Transportation (School of Business Administration)
L. E. Goodman	Civil Engineering
D. V. Harper	Production, Management and Transportation (School of Business Administration)
J. E. Holte	Continuing Education
M. J. Huber	Civil Engineering
W. E. Ibele	Mechanical Engineering
H. Iskander	Architecture
S. J. Kahne	Electrical Engineering

Name	Department
K. S. P. Kumar	Electrical Engineering
R. F. Lambert	Electrical Engineering
W. R. Maki	Agricultural Economics
H. Moring	Economics
R. Plunkett	Aerospace Engineering
P. M. Raup	Agricultural Economics
G. O. Robinson	Law
F. P. Schoettle	Law
T. M. Scott	Political Science
C P. Straub	Environmental Health

Students pursuing degree programs as part of the Program in Urban Transportation enroll in the major department of their choice. They are then assigned two advisors, selected so that one will be able to advise on technical matters and one will be able to advise on socio-humanistic matters.

Graduate School

As with all other graduate students, the Graduate School maintains the official records of academic progress of students enrolled in the program. As with other fellowships, the fiscal administration of fellowship funds is performed by the Graduate School.

Research Contracts and Grants Section

Fiscal administration of funds under Federal grants is carried out by the Research Contracts and Grants Section of the Business Office.

Continuation of Program

It is the aim of the University of Minnesota to continue the Program in Urban Transportation after the expiration of Federal funds. The University and the individual faculty members consider transportation to be a major problem of urban areas in general and of the Twin Cities Metropolitan Area in particular. Furthermore, urban transportation is considered to be worthy of the attention of persons of the highest calibre. Thus, many of the faculty are committed to the study of urban transportation on a continuing basis.

No continuing financial commitments to faculty members are contingent upon the receipt of Federal funds.

Attention is directed, however, to the fact that for about the past 15 years there has been a growing tendency for graduate students to expect some form of financial aid from or through the institution. Thus, there may be a continuing need for funds to provide such student support.

RESEARCH COMPONENT

While research always has the objective of advancing knowledge, within the University it has certain additional objectives, including:

1. Providing a continuing source of information to keep instruction fresh.
2. Serving as an important part of the experience of the advanced student by giving him the opportunity to participate in the search for new ideas.
3. Providing techniques whereby other agencies can solve specific problems.

Within the porposed Program in Urban Transportation, research is expected to play all of these roles. To this end it is proposed that several projects related to urban transportation be undertaken. These projects have been grouped into the following broad categories:

Forecasting future transportation demands

Problems in urban mass transit

Other problems of urban transportation.

The table which follows lists the proposed projects under each of these categories. Descriptions of the projects follow the table in alphabetical order according to project designation.

A substantial portion of the budgets of research projects is allocated for stipends to research assistants (along with the indirect charges that are salary associated). While research assistantships are

primarily thought of as providing service to the research projects, they also represent important support to the individuals concerned. Furthermore, the research experience often influences the Assistant to enter the field which is the subject of the research.

On the pages following the table there is a narrative description of each project.

General Category	Project Designation	Project Title	Principal Investigator	Department
Forecasting Future Transportation Demands				
	CE	Forecasting Demand for Transportation and the Relationship to the Design of Transportation Facilities (Effects of Various Levels of Estimating Precision)	Matthew J. Huber	Civil Engineering
	Geog	Forecasting Area Demand for Suburban Mass Transportation	Russell B. Adams	Geography
Problems in Urban Mass Transit	BA	User Preference for Mass Transit in The Twin Cities Metropolitan Area; A Basis for Planning and Political Decision	Fred J. Beier	Management & Transportation (School of Business Administration)
	Econ	Quantification and Justification of Mass Transit Subsidies	Herbert Mohring	Economics
	ME 2	Research on Personalized Transit Systems	John Edward Anderson	Mechanical Engineering
Other Problems of Urban Transportation	EE	Studies of Command and Control in Urban Transportation Systems	K.S.P. Kumar	Electrical Engineering
	ME 1	Study of the Dynamics of Interaction Points Coupling Transportation Modes	Darrell A. Frohrib	Mechanical Engineering

Project BA: USER PREFERENCE FOR MASS TRANSIT IN THE TWIN CITIES METROPOLITAN AREA; A BASIS FOR PLANNING AND POLITICAL ACTION

PRINCIPAL INVESTIGATOR: F.J. BEIER

Project Objectives

The proposed project has two goals. The first objective is to sample the attitudes of Twin City residents in regard to the conditions under which they will use, or continue to use, public mass transit. The second objective is to determine at what point public mass transit becomes desirable to the potential user given that other transport alternatives, primarily the automobile, will increase in cost and inconvenience. The results of the proposed research will therefore identify two different points of consumer acceptance for mass transit systems; positive acceptance and acceptance due to deteriorating alternatives.

Background:

There are a number of factors which make the proposed research significant. First of all it is apparent that mass transportation is not appealing to the majority of potential users in the Twin Cities area. It is also becoming apparent that the present system would be incapable of satisfying the great variety of demands presented by all potential users. These facts represent a familiar pattern of declining patronage and service for mass transit systems. Yet it is increasingly important to stimulate demand for mass transit services. The reason for this is not so much that mass transit may be more economical for the user, but rather that the alternatives, e.g., the combination of automobiles and freeways, are becoming less desirable from a social point of view. Therefore, the question of how

good a mass transit system has to be in order to draw motorists off the freeways becomes a very relevant benchmark for planners and politicians as well as for local transport agencies themselves.

To highlight the previous point, there is some evidence that improvements in the local mass transit system will not generate sufficient patronage to contribute to the total profitability of the system and simultaneously reduce the use of automobiles to and from the CBD. For example, a study in Milwaukee found that 56 per cent of the respondents would continue to use their automobile regardless of what changes were made in the transit system.[1] Should this attitude also exist in the Twin City area public stimulus of mass transit demand is needed. Specifically, such attitudes would suggest that political decisions be made to increase the costs and inconvenience associated with intra-city car travel -- hence making mass transit systems more desirable. The proposed research would provide a series of guidelines for such political decisions -- identifying those factors, if any, to which the motorist will respond by switching from private to public transportations.

Research of this type has been conducted in other metropolitan areas. In addition to the Milwaukee study cited above, a similar study was performed in Baltimore and Philadelphia.[2] While these studies will provide valuable methodological inputs to the current proposal there will also

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[1] "The City of Milwaukee's Mass Transportation Problem", A Report by the Municipal Transportation Study, with Survey by Marquette University, College of Business Administration (1955).

[2] S. J. Hille, F. T. Paine, A. N. Nash, and G. A. Brunner, "Consumer Transportation Attitude in Baltimore and Philiadelphia", Transportation Journal, Summer, 1968, pp. 30-47.

be significant differences. For example, it is not at all clear that attitudinal research concerning mass transit systems in other cities is applicable to the Twin Cities area. Further, past research appears to focul strictly on the user's motivation for selecting a specific mode. However, in addition to developing such a criterion of acceptance for the local area, the proposed research will also identify factors which will contribute toward switching non-users to mass transit.

This proposal also has a critical relationship with the consultant's report currently before the Metropolitan Transit Commission. This report attempted to model conventional systems and evaluate their performance in terms of cost and service. However, determinants of service level are largely assumed or are based on the experience of different metropolitan areas. The proposed research could therefore serve as a basis for re-affirming the consultant's assumptions. It may also serve as an expansion of the consultant's report in that it will identify specific parameters which will increase mass transit utilization. For example, assumptions of automobile restrictions, tolls, and parking restrictions may be used to model the patronage potential of future transit systems.

Finally, the proposed research is both timely and will satisfy a need for specific public opinion sampling. Increasing concern over such problems as pollution and the bisection of our cities by freeways by large segments of Twin Cities residents may be reflected in a different attitude than that found in other cities. Further, simple yes or no choices, typified by elections for bond issues, may not be sufficient means of testing public opinions. For example, it has been hypothesized that part of the

explanation of the more than 60% positive vote for the BART project was due to the perception of voters that such a rapid transit system would make it easier for their neighbor to use public transportation -- thus leaving more room on the freeways for themselves. Therefore, it appears that a comprehensive sampling of public sentiment regarding potential use of transit systems is needed if it is to be used as a basis for planning.

Methodology

The first task of the proposed research is to review the current available literature concerning public opinion sampling of mass transit systems. This would include all relevant research developed for the local Metropolitan Transit Commission as well as for other cities. The purpose of this search is to identify discriminating factors with which to evaluate mass transit systems. For example, such a list of factors may include walking distance, waiting time, transit time, convenience of schedules, and any number of comfort factors such as air conditioning and the availability of seats. This literature search will also provide guidelines for the development of sample questions and procedures for sampling.

After the literature search a forced choice questionnaire will be developed. It will be designed such that it can identify respondents at various points along a continuum bounder by "never use mass transit" and "always use mass transit." The respondents will be grouped and their conditions for using mass transit, or continuing to use it, will be examined. The questionnaire will be structured so as to determine the following in-

formation about the various groups:

1. perception of respondents of the cost of automobile travel
2. those factors contributing to repeated use of mass transit system
3. those negative factors associated with automobile travel necessary to force respondents to use mass transit systems
4. those positive factors associated with existing and more exotic transit systems which will stimulate use of public transportation

In regard to the third category above, such factors as increased gasoline tax, tolls, parking fees, and licenses will be contrasted with a respondent's desire for driving. In regard to the fourth category, those factors which may be of importance to potential users will be examined in terms of the existing bus system as well as future possible developments such as rapid transit.

After its completion the questionnaire will be pre-tested and then sent to Twin Cities residents. The exact size of the sample is yet undetermined; however, it must be representative of the entire metropolitan area. Hence it must include suburban and urban areas, inner-city depressed areas as well as affluent neighborhoods, and areas with varying accessibility to existing transit lines. The questionnaires will then be tabulated and statistically analyzed.

Plans for Publication

It is anticipated that the research will serve as a basis for one or more papers to be submitted to appropriate journals.

Time Table

The following is the proposed time table of the above research project:

June 1 - July 1, 1970: Literature Search and Evaluation

July 1 - August 1, 1970: Questionnaire Preparation and Pretesting; Sample Definition

Project CE: FORECASTING DEMAND FOR TRANSPORTATION AND THE RELATIONSHIP TO THE DESIGN OF TRANSPORTATION FACILITIES

PRINCIPAL INVESTIGATOR: ASSOCIATE PROFESSOR M.J. HUBER

Objectives of the Project

Transportation systems, because of the permanency of the right-of-way and the large capital investment in structures and facilities, are built to anticipated demand for periods of twenty to thirty years in the future. In highway transportation planning in particular, there has come into begin a procedure for forecasting urban travel demand for some future year. Such procedures require a substantial investment of time and money in order to develop what is considered a minimum input for the planning process. The engineer designs the transportation facility to provide sufficient capacity to meet the forecast demand.

Procedures for forecasting inter-urban travel demand are less precise than those used in the urban problem. Recent studies (summer 1969) with the Minnesota State Highway Department have indicated that no satisfactory, rational method, (other than extrapolation of historical traffic growth rates) have been developed for forecasting inter-urban travel.

The objectives of this study are two-fold:

1. To develop a procedure for forecasting inter-urban travel, taking the experiences of developing urban travel models as a guide.

2. To review past performance in transportation forecasting, particularly on highways and streets, comparing existing operation and demand levels to those levels forecast at some past time. The purpose is not to question the forecasts made in the past (techniques used as recently as

five or six years ago were very crude and practicioners of the art at present question their own results) but rather to investigate the consequences of discrepencies between forecast and actual values. The particular purpose will be to relate the required precision of data needed for transportation planning to the type and cost of data collection used to provide the necessary input to the planning process.

Development of inter-urban travel model

The Minnesota State Highway Department has historical records of traffic volumes on inter-urban highways along with results of interviews with drivers who have been intercepted while traveling on rural roads. These two items provide a measure of the magnitude, direction, length and purpose of travel. The data have been collected and are available for all Minnesota urban areas with population in excess of 5000 persons (1960 census).

Demographic data on population, housing and employment are also available for each of these areas, together with a description (coded for computer analysis) of the rural highway network.

There are three basic steps which will be required in developing the travel model:

1. A determination of the number of trips which begin or end in a metropolitan area - models of this have been developed (1969) in a joint effort between the Department of Civil Engineering and the Minnesota State Highway Department.

2. The destinations of those trips developed in step 1 must be determined. Critical variables appear to be population at destination,

distance to destination and purpose of travel (a trip for groceries is likely only 1 to 4 miles; for more specialized shopping may be 5 - 50 miles; for recreation may be several hundred miles). The data for population and distance, as measured from each urban area, are presently coded and placed on punch cards in anticipation of further analysis.* Two models, a) the gravity Model and b) the Intervening Opportunity Model, both used in modeling urban travel patterns, will be tested, fitted and adjusted to duplicate inter-urban travel as presently observed. It is anticipated that the greatest part of the first year effort will be devoted to development of these models.

3. The travel between urban areas must be assigned to particular routes. This technique is well developed and the conversion of the output of step 2 to step 3 will be done by the State Highway Department.

Review of Past Performance and Error Analysis

During the second year of the study there will be a review of previously forecast and currently existing volumes on selected highway facilities, particularly in Minnesota. This will require a selection of existing facilities for which forecasts were made, a review of the volume forecasting technique and a survey of current volume. What is the nature and magnitude of variations between actual and forecast volumes? To what magnitude do these variations influence the present operation of the highway system? Are the existing magnitude and variations in volumes what might have been anticipated at the time the forecast was made? It is recognized that the number of roadway segments for which sufficient data are available might be limited because many roadways currently in

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* These data have been collected and partially analyzed under terms of a grant from the Program in Urban Transportation during the year 1969-1970. (Project CE-1)

operation were built without the need or use of sophisticated planning techinques. Those roadways which were planned with more sophisticated techniques are not completely constructed or have been in iperation for such a short time as to preclude the development of historical data.

This phase will be conducted by contacting the state highway department and urban transportation planning agencies for access to information about forecasting techinques used and historical results of various transportation planning projects. This data collection phase will require observations of present levels of operation (vehicular volumes or passengers per day or peak hour) as compared to forecast values. Further analysis of operating conditions (congestion, delay and travel time) will be required to evaluate discrepencies between observed and forecast values. It is anticipated that much of the information is presently available in records of the appropriate agencies and that on-site data collection will be minimized.

During the third year of the project the data collected during the first year will be collated and analyzed with the objective of making a critical review of the precision necessary for transportation planning. A study of incremental changes in forecast volume and the consequent influence in design of a highway or a highway network will be made. At what volume difference does it become necessary to redesign a highway, to add or subtract traffic lanes? How much variation from forecast volume can be tolerated by a change in level-of-service from that initially planned? How much "surplus" capacity is introduced by a decision to add one land to a roadway and how does this relate to tolerance in forecasting future volumes.

Are these tolerances in capacity of a roadway sufficient to permit less precise volume forecasts. If so, is it possible to decrease the sampling rate for transportation studies or to suggest new techinques for volume forecasting.

It is further anticipated that the review and analysis of precision requirements will have direct application to planning other modes of transportation with capacity characteristics which are different from those of highways.

Synopsis of 3-year program

First Year 1970 - 1971

Development and testing of inter-urban travel forecast model

Second Year 1971 - 1972

a) Completion of inter-urban model

b) Review of transportation segments with history of rational forecast and comparison to existing volumes date collection phase.

Third Year 1972 - 1973

Critical review of differences between forecast and actual volumes. Development of criteria to evaluate required precision of forecast and development of guidelines for evaluating impact of forecast errors on transport facilities of fixed capacity.

Project Econ: QUANTIFICATION OF ECONOMIC JUSTIFICATIONS FOR URBAN MASS TRANSIT SUBSIDIES

PRINCIPAL INVESTIGATOR: PROFESSOR H. MOHRING

Summary

The immediate goals of the research project are to develop models of use in specifying the optimum size, type and spatial distribution of urban transportation facilities and to use these models as the basis for developing procedures to estimate both the social costs involved when optimum investment and pricing procedures are not employed for urban transportation activities and the magnitude of the possibly desirable mass transit subsidies that stem from the existence of scale economies and nonoptimal pricing and investment procedures. Numerical illustrations of these models are being developed using data presently or prospectively available for the Twin Cities Metropolitan Area. The models and the theoretical work underlying them should prove directly applicable to the transportation problems of other urban areas and, with suitable modification, both to other problems involving the optimal spatial distribution of activities that involve scale economies and to other optimization problems involving multiple characteristic commodities whose production is subject to increasing returns.

The Problems

A considerable body of theoretical and empirical work has accumulated on the characteristics of an optimum pricing system for existing transportation networks. Most writers on the subject seem to agree that achieving Pareto-optimality would require each auto operator to pay not only

the costs he bears himself but also a toll equal to the costs his trip imposes on other travelers by adding to the level of highway congestion. Strotz (15) and Mohring (6,8) have proved a proposition that can be expressed in the following terms: In the absence of scale economies, employment of two quite simple operating rules would lead to both a Pareto-optimal utilization of an existing (perhaps non-optimum) transportation network and, ultimately, a long run optimum network. These rules are: a) establish short run marginal cost prices for each user--each subway, bus or private passenger vehicle traveler--of each link in the existing network; and b) alter the size of each link to the point where toll revenues equal the costs to the authority of providing that link--maintenance and other operating costs, depreciation, and imputed interest on invested capital. In the absence of scale economies, each component of an optimum transportation system would be exactly self-supporting. A definite welfare loss would result were any component of the system to be subsidized.

Factors do exist, however, that make this "no deficit" financing principle inapplicable to current and possibly to prospective urban transportation systems. These factors can usefully be grouped under two broad headings: a) non-optimum pricing and investment policies; and b) the presence of scale economies in the provision of highway and, to an even greater degree, mass transportation facilities. A third set of factors that might obviate the "no deficit" principle--externalities in the provision and use of transportation facilities--will not be dealt with in the proposed study.

The several published studies (see e.g., 1,7,16) that have a direct or indirect bearing on optimum highway toll structures seem to agree in one very important respect: The optimum toll increases rapidly with the ratio of the actual number of trips being made on a street or highway to the maximum number that could be made. To take an extreme example, it has been estimated that the optimum tolls for the average Twin Cities Metropolitan Area (TCMA) street were approximately 0.2 and 19.1 cents per vehicle mile respectively between 2:30 - 4:00 a.m. and between 4:30 and 5:00 p.m. on the average 1958 weekday (7). Gasoline taxes--the principal highway user "toll"--averaged out to about 0.5 - 0.7 cents per vehicle mile and do not vary appreciably with traffic levels. This being the case, the general financing principle noted above would seem to support an expanded highway construction program. Indeed, (8) reports estimates that the marginal rate of return on new freeway construction in the TCMA may be as high as 300 percent and that currently planned freeway construction falls far short of the level necessary to equate optimum tolls with capital costs in the TCMA. Therefore, since the contribution to highway congestion of a bus rider is considerably smaller than that of an automobile passenger, a mass transit subsidy program might very well prove desirable, at least in the short run.

A variety of systems have been suggested for varying tolls on urban transportation facilities through the day. All of them present substantial--perhaps insuperable--legal, political, and/or cost obstacles. As a matter of general principle, if it is impossible to establish marginal cost prices in one line of activity, the best alternative pricing system

would not necessarily entail marginal cost prices for the remaining activities. This "second best" consideration may also tend to support mass transit subsidies.

Neither the economics nor the transportation literature seems to contain much quantitative information on the magnitude of scale economies in the construction and maintenance of highway networks. Fairly obvious scale economies do seem to exist, however. For example, the cost of paving six lane expressways is less than 150 percent of that for four lane expressways. The same considerations apply to overpasses and to the amount of land required for rights of way.

As for mass transit services, the limited available evidence suggests that costs per seat mile decrease substantially with increases in bus size. For this reason, the provision of mass transit services involves perhaps substantial scale economies. Once a rider is aboard a bus, an increase in the number of passengers very likely increases his time en route by increasing both the number and the duration of stops. At the same time, however, an increase in the demand for trips on a route would likely result in increased service frequencies and therefore in reduced waiting time. Some rough estimates suggest that the scale economies associated with increased service frequencies imply an optimum mass transit subsidy in the TCMA equivalent to roughly 30 percent of current mass transit fare revenues. This work will be reported in (12).

Objectives of the Research Project

The models that have been and will be developed to estimate welfare losses and optimum subsidy policies are closely related to those described

in part C of (7) and section III of (9). As an example, one of these involves the assumptions that the same price must be charged in peak and off-peak demand periods, that freeway construction costs are on the order of those which prevail in the TCMA, that a relationship exists between the volume/capacity ratio on the one hand and vehicle operating and travel time costs on the other which approximates the results of a number of empirical studies with reasonable precision, and that total system revenues must exactly cover total system costs. The measure of welfare loss developed can be interpreted roughly as the fraction of resources devoted to the production of trips which is, in effect, wasted in the sense that elimination of the pricing constraints would make it possible to devote these resources to other activities without reducing the level of utility derived from trips. For the combinations of cost and demand parameters that have been tested, this welfare loss measure runs between about 0.5 and 25 percent.

The models which have so far been developed incorporate only one transportation mode and do not adequately reflect a number of important ramifications of the facts a) that, in the real world, origins and destinations are distributed through space b) that, because of the existence of scale economies and indivisibilities, the costs of providing both highway and transit facilities with a given capacity increase both with increases in the frequency with which access to them (in this form, for example, of freeway interchanges and transit stations) is provided and with decreases in the spacing between them, and c) that consumers differ in the monetary values they place on each of a variety of non-monetary

attributes--time in transit, in particular--of the trips they take.

To elaborate, neither the first nor the third fact mentioned above would pose any problems in a constant returns to scale world. In such a world, it would be possible to connect each origin-destination pair with a sufficient number of transport facilities to meet the exact travel time and other specifications of each customer group. That indivisibilities and scale economies do exist forces compromises to be made: In general, the cost of a given number of passenger or ton miles of transportation capacity decreases as the size of the individual facilities providing them increases. However, reducing capacity costs in this fashion carries with it the penalties both of increasing the circuity of travel by requiring each facility to serve a larger number of origin-destination pairs and of reducing the number of consumer groups whose specifications can exactly be met. Thus, it seems meaningful to talk of optimizing both the number of types of transportation service provided and the circuity involved in a given service.

This optimization problem can probably most effectively be dealt with by exploring the implications of scale economies and indivisibilities for Pareto-optimality within the framework of consumer theory suggested by Becker and Lancaster (1,2,3). That is, its solution can perhaps most easily be found by developing the characteristics of Pareto-optimality in a world in which a) a consumer values an individual good not in its own right but rather because of the characteristics it possesses (e.g., size, color, horsepower, nature of trip, etc. for an automobile), b) individual consumers differ in the relative utilities they attach to

different characteristics, and c) the average cost of manufacturing an individual commodity (e.g., autos each with the same size, color, horsepower, etc.) decreases with the number manufactured.

The broad goals of the research programs, then, are:

a) to undertake the general theoretical exploration suggested in the preceding paragraph;

b) to apply these conclusions to relationships between, on the one hand, the capital and operating costs of various types of transportation facilities (city streets, expressways, bus, and various forms of rapid transit service) and, on the other, their size, spacing, and the frequency with which access to them is provided that will be developed as part of the research program described by the Mechanical Engineering Department to specify the characteristics of optimum transportation networks in hypothetical urban areas differing in origin-destination densities and in such attributes as the population's distribution of travel time values; and

c) to determine both the changes in transportation network characteristics called for by various non-optimum pricing and financing schemes and the welfare losses associated with these elements of non-optimality.

Numerical illustrations are being developed in the course of undertaking steps b) and c). These are, to a large degree, based on data from the TCMA that are either presently at hand or can be obtained fairly easily from the Metropolitan Transit Commission, the State Highway Department and the Metropolitan Council.

Present Status of the Research Project

The research project described above was initiated with the support of a two year award by the National Science Foundation which began in September 1967 and is currently being pursued with the aid of a grant to the University of Minnesota's Center for Urban and Regional Affairs by the U.S. Departments of Transportation and of Housing and Urban Development. The portions of the research that have been completed to date are summarized in (9), (11), and (12). A revised version of the theoretical portions of (9) will appear as (10) in the American Economic Review for September 1970. Completion of the empirical work described in Part III of (9)--estimates of the welfare costs of the various pricing and investment constraints involved in urban transportation--has proven to be a frustratingly time consuming task. As things stand at present, it appears that an article (13), by Mohring and two of the research assistants who have participated in the project, Thomas Pinfold and Marvin Kraus, will be available by May 1970. A revised version of (9) will appear in a volume of conference proceedings being edited by William Vickrey for the University of Wisconsin Press. The theoretical portions of this article have provided the foundations for Pinfold's doctoral dissertation, (14), in which he is using University of Michigan Survey Research Center data to analyze consumer choices between public and private transportation. His study should be completed by September 1970. The theoretical development of (11) has also provided the basis for a study currently being undertaken by Mohring using the SRC data to analyze household spatial equilibrium patterns and biases that arise in the utlilization of land

value gradients to infer the values households place on their travel time. A draft report dealing with these analyses should be available by May 1970.

A model has been developed to determine optimum station spacings and service frequencies for bus routes. The parameters involved in this model include the cost of providing a bus hour of service, the time required to decelerate and accelerate when a stop must be made and to load and unload passengers once the bus is stopped, the number of passengers served per mile of route, the average length of trip, and the values travelers place on the time they spend walking to bus stops, waiting there for service to come, and actually riding on buses. A computer program to determine optimum station spacings and service frequencies for alternative values of these and other parameters has been written and is currently being debugged. The model can readily be modified to deal with other forms of mass transit--rail rapid transit, in particular. This model will be incorporated with others currently being developed to achieve the objectives of "goal b)" described above. It should prove possible to complete this work as well as that described under goals c) and d) by continuing the project at approximately its present level of effort through the summer of 1971.

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Project EE: STUDIES OF COMMAND AND CONTROL IN URBAN TRANSPORTATION SYSTEMS

PRINCIPAL INVESTIGATOR: ASSOCIATE PROFESSOR K.S.P. KUMAR

Introduction

Rapid transit systems and other vehicular transportation systems in the future urban environment will contain a central processor (computer) for efficient utilization of the system and the roadways. The central processor will require information such as vehicle location, transportation demands, traffic flow, etc. It will perform functions such as command and control of vehicles, dispatching of vehicles, etc. Studies are needed to provide the control techniques to be used.

Problem for First-Year Study

We shall consider a system using exclusive right of ways and providing station to station service. The vehicles can be assumed to personalized small cars.

In command and control mode, we need the capability of optimally scheduling the vehicles for providing efficient and safe service. An initial effort has been made to determine the co-ordinates of the vehicles by making a small number of appropriate observations. This problem may be stated as follows. Is it possible to observe the state of the entire network of vehicles by judiciously making a small number of observations on the position, velocity, headway, etc? In a doctoral thesis under preparation, conditions under which this can be done are being developed. It is proposed to examine the results in detail and produce

efficient computational algorithms. When this phase is completed, it is proposed to use the information to generate control strategies in order to dispatch the vehicles efficiently and safely.

In another study, efforts have been made to develop traffic flow models and to estimate the flow in real time using digital computers. The results have been studied for a one dimensional model and simulation has shown very good results. Unfortunately, the algorithm becomes complex for higher dimensional models. It is proposed to study the simplification of these algorithms for efficient computational purposes. It is anticipated that actual tests will be conducted on a stretch of the interstate belt line around Minneapolis-St. Paul with the co-operation of the Minnesota Highway Department.

The flow measurement algorithms (developed by Mr. G.B. Lamont under an Urban Transportation Fellowship) will be simplified to speed up computations at the same time maintaining suitable convergence properties. This will be tested on the personalized vehicle mass transit model being developed in the Mechanical Engineering Department. It is anticipated that considerable interaction will exist between this phase of the project and that of Mechanical Engineering.

During this period the conditions under which we can observe the whole system by making a relatively small number of postion and velocity measurements on the vehicles will be pursued further. Results for a smaller dimensional system are being summarized in the doctoral thesis of Mr. E. Griffith and are being readied for publication. Efforts will be spent to determine the type of measurements to be made, the accuracy

of these measurements, the type of sensors used to make these measurements. The state of the entire system then should prove invaluable in designing control strategies for flow along a line, for safe merging at entrance and exit ramps, maintaining a safe headway, alarm signalling in case of failure, etc.

Project Geog: FORECASTING AREAL DEMAND FOR SUBURBAN MASS TRANSPORTATION FACILITIES IN THE TWIN CITIES METROPOLITAN AREA (TCMA)

PRINCIPAL INVESTIGATOR: ASSOCIATE PROFESSOR R.B. ADAMS

Objectives

1) To provide small-area estimates of population, employment, vehicle ownership, and other traffic-generating characteristics along existing and projected corridors of high-volume usage in the surburban TCMA;

2) To estimate travel demand in each area for the year 1985 (or specified other target dates) with sub-sets of demand for travel along the defined corridors into the central cities;

3) To generate, by variable modal splits, the amoung of traffic which might be expected to utilize transit services on freeways and major arterials (bus), new and existing rail lines, and future innovations (mono-rail, e.g.).

The overall aim is to develop a general method of providing traffic input for model testing and simulation of mass transit feasibility. Related research proposals will be integrated via cooperative effort to specify "working parameters," such as types of facilities, spacing of interchanges and stations, and modal shares, based upon experiences in other urban areas. In addition, the training and educational aspect will be promoted by the inclusion of graduate students as project personnel; also, it is anticipated that trainees will take designated courses and participate in joint seminars in furtherance of their graduate program.

Previous Work

During 1969-70 this project has consisted of collecting source

material and data toward identification of areas and corridors of high density traffic having potential for mass transit.

Proposed Tasks For 1970-71

The work proposed for 1970-71 may be classed as "system testing", and will consist of the following:

1) Under various assumptions of types of facilities and station spacing, by specification from related projects, the estimated future traffic will be examined to determine probable use volumes. Proportions of future traffic expected to use mass transit between nodes will be generated.

2) Field interviewing. It is believed that small-sample household interviewing will be valuable information to estimate "real" versus probable transit usage. (Actual household interviewing will be limited to the Twin Cities Metropolitan Area).

Proposed Tasks For 1971-72

It is proposed that during 1971-72 the following activities be undertaken: The results of the research will be published initially as a technical report of the Center for Urban and Regional Affairs. Thereafter, one or more papers will be prepared for technical journals, as appropriate.

Project ME 1: A STUDY OF THE DYNAMICS OF INTERACTION POINTS COUPLING TRANSPORTATION MODES: SECOND YEAR

Problem Statement

The second year activity is intended to translate the queueing theory (developed under the Department of Transportation sponsorship) by Mr. Robert Tomisak during his 1969-1970 doctoral study into an optimization model. At this point in time, the $2^n - 1$ simulataneous difference equations similar to Hunt's[1] have been reduced to n equations representing flow through an interaction node. This has been a very significant step in evaluating the flow through a multi-station node. Presently, a series n - station array has been studied.

The next phase of the work will extend the simplified queueing model to parallel branches. The optimization study will evolve a search strategy to seek optimum solutions (the number of branches, stations per branch) for various kinds of design criteria. Little work appears to have been done using search methods on random processes. However, the flow equation forms resulting from the first year of study are in a sufficiently tractable form for repetitive computation to be feasible.

It is evident that the quality of an interaction point may be assessed several ways. Minimum traverse time per user, minimum traverse time per vehicle, minimum queue size, maximum utility per loading-unloading site are typical considerations. A sensitivity analysis will be performed to determine the effect of various criteria on the optimum station configuration. Several mass transportation systems have been pro-

posed with provision for series loading of vehicles. At this point, it appears uncertain that this strategy is wise, as it is very dependent on the destination objectives, queue size, and vehicle availability at the loading site. The implication of loading strategy on the interaction as well as the basic transportation modes should be understood, as it may be a governing factor in establishing the physical properties (flexibility, etc.) of the participating transportation modes.

Consultation should be conducted with behavioral sciences personnel to provide a basis for judging the effect of human response on traffic density and traverse time within interaction points. For example, excessive waiting times could generate flow back into a given transportation mode, as decisions are made to return to the original destination or to use alternate routes.

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1 Hunt, G. C., "Sequential Arrays of Waiting Lines", Dissertation, M.I.T., 1956

Project ME 2: RESEARCH ON PERSONALIZED TRANSIT SYSTEMS

PRINCIPAL INVESTIGATOR: ASSOCIATE PROFESSOR J. E. ANDERSON

Background

This is a proposal to continue research and training in urban transportation in the Mechanical Engineering Department in a vein begun with funds obtained from the first years' grant. We first describe the work currently underway, then indicate how we would like to extend that work next year.

The training program is being carried out through a regular Inter-departmental Design Program at the senior level operated under the auspices of the Design Center in the Mechanical Engineering Department. Each year 130 - 150 Senior mechanical and aeornautical engineers go through this year-long program which takes 4 - 6 student hours per week. This year the writer has been guiding three ten-man projects in urban transportation design:

1) An intercampus transit system
2) A central business district people moving system
3) An interairport transit system

In all cases, the projects were addressed to real needs of the community, and were conducted with the enthusiastic cooperation of the public agency involved; respectively, the University of Minnesota Planning Office, The Planning Department of the City of Minneapolis and the Metropolitan Airports Commission. Pertinent data has been

generously offered by these agencies and the writer has been informed by representatives therefrom that they will be much interested in the results which are to be published in the form of reports at the end of the spring quarter.

In each project, after preliminary studies of the overall problem including presentations by the agency involved, the students chose a group leader and broke up into three groups. The first group was responsible for determining the required capacity of the system; i.e., the capacity of a single line and the capacity of stations and how these quantities varied with different station and line locations. The second group was responsible for physical location of the lines and stations. In later phases they were responsible for design of the track and layout of the station. The third group was responsible for designing the vehicle. They have investigated various possible vehicle systems and have been conducting trade-off studies against criteria they have established. It has been of course necessary to have a great deal of interaction between these groups and each has modified its ideas in view of the results of the others.

In the three systems the conditions are quite different, indicating need for quite different types of hardware. In the campus system the most difficult constraint is to get the needed volume of traffic between two campuses about three miles apart within the 15-minute break between classes. During the remainder of the hour, the load is light by compari-

son. These needs are being met by use of trains of moderately sized cars.

The central business district is characterized by high-volume rush hours, many stops, shorter distances and a lower speed requirement. Since the load is not so sharply reached, smaller cars with short headways with origin destination lines appear practical.

The interairport system, on the other hand, requires movement of a fairly large volume of people (10,000 per hour at most) between two points about 20 miles apart. Much higher speeds are needed for maximum efficiency, and an end-of-the-line distribution system is needed to drop people off close to their planes.

Our research efforts have complimented these student projects in that we have studied:

1) The problems of controlling a line of small independent vehicles in such a way that, in spite of slowdowns, the vechicles will not collide with one another, and

2) The general characteristics required of a personalized transit system for the Twin City Area. The first of these studies has been carried out on the University's Hibred Computer by a graduate student under the writer's supervision and has already yielded useful conclusions in regard to control of cascaded vehicles. The second study has been conducted by the writer as he has tried to see how to integrate the various systems being designed in the students' projects into an area-wide system. A report on this study will be published very shortly.

Proposed Work

Next Year, we would like to build upon the work of the past year in all of the projects discussed. In all cases, new groups of students starting with the reports we will have written and the knowledge obtained by the principal investigator will help us to carry this work much farther.

To carry out these plans, during the coming school year funds will be required for one half-time research assistant, and one eighth-time secretary to help write for data, handle the growing transportation design library, type reports etc. Funds will also be needed for travel, computer time, and supplies.

TRAINING PROGRAM

General Outline

The training program in Urban Transportation includes courses which undergraduate students will be encouraged to take, and specialized degree programs will be provided for graduate students. Training fellowships will be provided for three levels of graduate students:

A. Recent recipients of the bachelor's degree

B. Holders of the master's degree

C. Persons engaged in professional practice in a field related to urban transportation who wish to return to the University for graduate study to broaden their viewpoints and to learn new techniques that will assist them in their profession.

Each graduate student selects a discipline relevant to urban transportation, such selection to be made from the list of disciplines having established graduate programs.

In addition to formal degree programs, there are seminars with joint participation of faculty, students and members of local government agencies and private industry interested in problems of urban transportation.

Short courses are contemplated to bring to those interested concentrated information on a specific subject.

As a support to the training program a library of urban transportation literature is being collected.

Advanced Degree Programs

Each graduate student participant in the Urban Transportation Program, after being admitted through normal Graduate School channels* is enrolled in an established discipline of his choice with the objective of pursuing a program leading to an established, advanced degree. He is assigned two advisors by the Administrative Committee of the Interdisciplinary Program in Urban Transportation. These advisors will in general be drawn from the Faculty Advisory Panel. One represents a technical field and one represents a socio-humanistic field. Each student, with the help of his advisors, plans a program of study majoring in the discipline of his choice but with a strong interdisciplinary relevance to urban transportation.

Students participating in the Program in Urban Transportation are expected to participate in a core seminar described in this document. Other course work relevant to the students' interests is drawn from regular University courses as discussed herein.

Students applying for the Master's degree are strongly urged to follow Plan A (the plan which includes a thesis -- see discussion under Curricula for Graduate Study). Where feasible, arrangements are made for thesis

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*In addition to normal graduate school application forms, each applicant seeking participation in the Urban Transportation Program(with or without financial support) will file a special application.

research to be conducted in an interdisciplinary manner. The degree received by each student is that normally conferred in the discipline of his selection. In addition to the normal degree diploma, each student completing a degree under the Program in Urban Transporation receives an appropriate certificate.

Curricula for Graduate Study

The University offers both the Master's and Ph.D. in many fields. The Master's degree is normally the M.A. in non-technical departments, and the M.S. degree in technical departments. There are currently two options for a Master's Degree program:

Plan A - A minimum of 18 quarter credits in the major field and 9 credits in a minor field plus a Master's Thesis.

Plan B - A minimum of 45 quarter credits, of which at least 21 credits are in the major field and at least 18 credits are from at least two related fields with a minimum of 6 credits required in each. Also requires 3 papers (of the quality but not the range of an M.S. thesis) in 3 of the courses.

In addition, graduate students in several of the engineering departments will have the opportunity of pursuing studies leading to the Master of Engineering degree, which calls for a design project rather than a thesis.

Curricula for advanced study in urban transportation will normally be

"tailored" for each student in relation to his previous training and career objectives.

The Department of Civil Engineering has initiated an M.S. program with a specialization in Urban Transportation. Sample programs for the Master's degree are detailed on the following page. They illustrate the flexibility and wide choice of disciplines open to Civil Engineering students under this option. Similar programs, combining a wide range of options around a disciplinary core, are also available in other technological and social sciences which are joining in this proposal.

An undergraduate design training program also illustrates the cooperative efforts already initiated by three of these departmental faculties. The design program has been developed by the Department of Aeronautics and Engineering Mechanics, Civil Engineering, and Mechanical Engineering. One hundred fifty students are involved; faculty is drawn partly from Twin Cities industrial design positions; and the approach to these projects offers opportunity for graduate students to participate both as leaders of undergraduate teams and as advanced seminar members.

Current Course Offerings

A wide spectrum of courses is available for inclusion in urban transportation programs. The following listing of these courses suggests several disciplines from which major students might bring a highly relevant substantive study of some aspect of the transportation system;

TYPICAL PROGRAM FOR M.S. IN CIVIL ENGINEERING: PLAN A

Fall Term			Winter Term			Spring Term	
	Seminar in Urban Transportation	(3)	CE 130 Introduction to Transportation Planning	(3)	CE 215	Advanced Transportation Planning	(3)
CE 210	Theory of Traffic Flow	(3)	CE 211 Urban Traffic Operations	(3)	CE 212	Freeway Traffic Operations	(3)
QA 151	Elements of Statistics	(3)	IE 198 Design and Analysis of Experiments I	(3)	IE 199	Design and Analysis of Experiments II	(3)
		9		9			9

TYPICAL PROGRAM FOR M.S. IN CIVIL ENGINEERING: PLAN B

Fall Term			Winter Term			Spring Term	
	Seminar in Urban Transportation	(3)	Seminar in Urban Transportation	(3)		Seminar in Urban Transportation	(3)
CE 210	Theory of Traffic Flow	(3)	CE 130 Introduction to Transportation Planning	(3)	CE 215	Advanced Transportation Planning	(3)
CE 158	Airport Design	(3)	CE 211 Urban Traffic Operations	(3)	CE 212	Freeway Traffic Operations	(3)
QA 151	Elements of Statistics	(3)	IE 198 Design and Analysis of Experiments I	(3)	CE 152	Geometric Highway Design or	(3)
					CE 112	Aerial Surveys and Photogrammetry	
IE 130	Introduction to Operations Research	(3)	Geog 167 Location and Geographic Design I	(3)	Geog 168	Location and Geographic Design II	(3)
		15		15			15

Note: As courses in mass transit are developed, they may be substituted as appropriate.

but it also suggests the rich variety of supporting fields. It should be emphasized that this list of courses -- lengthy as it is -- actually contains relatively little overlap and probably falls short of representing the variety of approaches and substantive knowledge required in everyday agency operations. The most important component of this or any program, therefore, is the integrating or core seminar.

Current Courses Relevant to Urban Transportation

Architecture

Arch	131	Planning: Theory and Methodology
Arch	132	Planning: Urban Function and Structure
Arch	133	Planning: Housing and Community Facilities

Business Administration

QA	158	Quantitative Approaches to Administrative Problems
QA	171	Statistical Methods for Sample Surveys
QA	181	Quality Control and Industrial Statistics
QA	191A-B	Statistical Methods in Business Administration
MIS	209A	Introduction to Hardware and Software Systems
Mgmt	150	Fundamentals of Management
Trans	154	Fundamentals of Transportation
Trans	184	Carrier Management

Civil Engineering

CE	130	Introduction to Transportation Planning
CE	151	Advanced Highway Laboratory
CE	152	Highway Design
CE	153	Soils in Highway Engineering
CE	154	Design of Highway and Airport Pavements
CE	156	Highway Traffic Engineering
CE	158	Airport Design
CE	168	Public Works Engineering
CE	210	Seminar in Theory of Traffic Flow
CE	211	Seminar in Urban Traffic Operations
CE	212	Seminar in Freeway Traffic Operations
CE	215	Seminar in Advanced Transportation Planning
CE	280, 281, 282	Civil Engineering Research

Economics

Econ	101	Introduction to Decision Theory
Econ	140	Economics of Location and Transportation
Econ	185A-B-C	Microeconomic Theory
Econ	195A-B-C	Decision Making and Operations Analysis

Electrical Engineering

EE	107-8	Linear System Analysis
EE	129A-B	Control Systems

Geography

Geog	165	Urban Geography
Geog	167-8	American Cities - Location and Geographic Design
Geog	181-2	Statistical and Advanced Cartography
Geog	184	Air Photo Interpretation
Geog	187	Quantitative Research Design
Geog	188	Area Sampling and Analysis
Geog	200 & 301	Directed Reading and Research Problems (Student Choice)
Geog	221-2-3	Seminar: Quantitative Geography
Geog	256-7-8	Land Use Planning
Geog	271-2-3	Historical Economic Geography

Industrial Engineering

IE	100	Introduction to Industrial Engineering Analysis
IE	120	Probability Models
IE	130	Introduction to Operations Research
IE	172	Manufacturing Cost Analysis
IE	133A-134A	Mathematical Models in Operations Analysis
IE	167	Materials Handling
IE	170	Production Planning and Control
IE	171	Quality Control
IE	173	Engineering Economic Analysis
IE	180	Management for Engineers
IE	182	Industrial Safety
IE	193	Introduction to Optimal Control and Dynamic Programming
IE	195-6	Applied Industrial Engineering
IE	198	Design and Analysis of Experiments I
IE	199	Design and Analysis of Experiments II

Law

Law	137	Land Use Planning
Law	140	Administrative Law
Law	148	Seminar: Public Affairs (Legal problems in Minnesota public affairs)
Law	159	Local Government Law
Law	164A	Regulated Industries
Law	193	Seminar: Urban Affairs

Mathematics

Math	133A-134A	Probability with Technological Applications
Math	164-5-6	Theory and Programming of Modern Digital Computers
Math	173-4-5	Elementary Partial Differential Equations
Math	178	Probability
Math	178A-B-C	Introduction to Probability
Math	184	Elementary Numerical Analysis in Engineering
Math	185-6	Numerical Analysis in Engineering
Math	280A-B-C	Mathematics of Computers and Control Devices
Math	285A-B-C	System Programming
Math	293	Information Theory

Mechanical Engineering

ME	123	Creative Engineering
ME	127	Friction and Lubrication
ME	129	Vibration Engineering
ME	146A	An Introduction to Combustion and Propulsion
ME	170	Manufacturing Processes
ME	191-192-193	Mechanical Engineering Design
ME	197	System Analysis and Control
ME	198	Industrial Instrumentation and Control
ME	199	Advanced System Analysis and Control
ME	223	Advanced Vibration Engineering
ME	224-5-6	Advanced Applied Dynamics
ME	296-7-8	Feedback Control Systems

Mineral Engineering

MinE	240	Advanced Concepts in Drilling of Rocks

Political Science

Pol	115	State Government
Pol	116	Introduction to Community Politics

Political Science (Cont.)

Pol	118	Metropolitan Government and Politics
Pol	130-131	Administrative Processes

Public Administration

PA	210	Public Administration and the Political Process
PA	212	Issues in American Public Policy - Transportation
PA	270A	Administrative Theory and Behavior - Transportation
PA	270B-C	Administrative Management - Transportation
PA	280A	Local Administration
PA	281	Law and Urban Affairs
PA	282A-B-C	Administrative Internship (with a Transportation agency)
PA	283	Research (in urban transportation administration)
PA	247	Urban Development
PA	265	Intergovernmental Administrative Relations
PA	284	Individual Reading and Research

Public Health

PubH	153	Principles and Methods of Accident Prevention
PubH	154	Special Studies in Accident Prevention
PubH	155	Introduction to the Air Pollution Problem

Statistics

Stat	121-122-123	Theory of Statistics
Stat	131-132-133	Theory of Statistics
Stat	191-192-193	Analysis and Design of Experiments
Stat	194	Introduction to Correlation and Multivariate Analysis

Sociology

Soc	111	Population Theory
Soc	115	Social Aspects of Housing and Standards of Living
Soc	145	Urban Sociology
Soc	245-246	Seminar in Urban Sociology

Recently Added Courses

Geog	172	Transportation Geography
Psy	114	Engineering Psychology

Core Seminar

All students in urban transportation, regardless of discipline, are expected to participate in an Interdisciplinary Seminar in Urban Transportation. This seminar has been organized by the Program in Urban Transportation and includes students, faculty and participants from government and industry. (Students receive degree credit by enrolling under appropriate general seminar course numbers in their respective departments.) The seminar gives heavy emphasis to problems of interaction and communication in planning, research, and execution of plans and also to the development of familiarity and mutual understanding of the various techniques and systems involved in the solution of urban transportation problems. Weekly meetings are held throughout the academic year.

Lectures are presented by faculty members and by guest speakers drawn from the agencies and private business concerned with urban transportation, not only in the Twin City area, but also from across the nation. Each graduate student participant is asked to present a paper at an appropriate time.

Workshop in Interdisciplinary Design

On the recommendation of the Minnesota Highway Department (See Appendix D), it is proposed that a workshop on Interdisciplinary Design of Highways be conducted during the fiscal year 1970 - 1971. Such a work-

shop would bring together personnel of city, county and state agencies concerned with the highway design. There would be the objective of broadening the viewpoints of the design processes. Emphasis will be on the economic, sociologic, and aesthetic consideration.

To prepare for this workshop, it would be expected that one professor each in Economics, Sociology, Architecture and Civil Engineering Departments spend one quarter time for one academic quarter. The cost of this effort is estimated as $6433. Of this amount, $3433 is proposed as a part of Federal sponsorship. An amount of $3500 will be sought from the Minnesota Highway Department.

Financial Support for Students

In order to encourage highly qualified students to direct their efforts and interests toward urban transportation, fellowships are offered to such students.

In addition to fellowships for the most highly qualified students, other students may receive financial assistance in the form of Research Assistantships.

Selection of Recipients of Fellowships

The selection of fellows is made by the Administrative Committee, according to the following criteria. In each class, selection of fellowship recipients from the group of applicants is made on the basis of the relative qualifications of the applicants. There is no pre-set quota by discipline:

Recent Recipients of the Bachelor's Degree:

Interest in urban transportation and promise of outstanding future contributions as indicated by an excellent academic record and letters of recommendation from professors and from supervisors of part-time employment, if any.

Holders of the Masters Degree:

Interest in urban transportation and promise of outstanding future contributions as indicated by excellent academic record, letters of recommendation, copies of master's thesis or other master's degree reports, and copies of publications, if any.

Candidates Returning from Professional Practice:

Attention will be given candidates' academic records; but emphasis will be placed on letters of recommendation, copies of reports, designs, publications, etc., as evidence of superior performance and interest in urban transportation.

Fellowship Stipends

Fellowship stipends for 1970 - 71 will be in the range of $3000 to $5000 for a 9-month academic year. The exact amount will depend upon the background of the particular recipient. Where appropriate, dependency allowances for up to 3 dependents will be offered. In no case will the stipend exceed $6500. Tuition and fees may be offered in addition to a stipend.* Book allowances of up to $75 may be offered.

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* For 1969-70 tuition and fees for the 9-month academic year are $561 for residents of Minnesota and $1251 for non-residents. Rates for 1970-71 have not yet been published.

URBAN TRANSPORTATION LIBRARY

A collection of literature covering the various aspects of urban transportation is being established at the University of Minnesota as a support function to the Program in Urban Transportation. This collection will serve faculty, students, and interested members of the community by providing fast access to work done in the field as reported in research studies, transportation plans, and many other types of documents.

Special Problems In Urban Transportation Literature

The interdisciplinary nature of urban transportation brings problems in identifying, acquiring, and managing the literature. Because relevant information comes from diverse fields, a variety of sources must be consulted to learn of new studies and reports. Once acquired, there are problems in cataloging or indexing the information for later retrieval as entry from several viewpoints is required. Circulation procedures to make the material available to the user are also required. In response to these problems, the following approaches are being implemented. Information and new publications are actively sought by checking announcement bulletins issued by organizations in the fields related to transportation.

Although it is important to place this collection in use as rapidly as possible, much of the transportation literature is in reports and other formats that do not readily fit into the University Library system, in that the cataloging of such materials is inadequate and slow. Furthermore, the branch libraries most concerned with transportation have very limited space for new collections. Thus, transportation literature is being acquired in several departmental collections. Work is needed to bring these collections together and/or provide a unified catalog.

Recent Studies of Microfiche

During the past year (starting under another grant and continued under the Program in Urban Transportation) studies have been made of the feasibility of acquiring, storing, and circulating a transportation collection on microfiche. The storage medium for roughly 85% of one collection is microfiche, giving substantial savings in both cost and space. Most of the microfiche are purchased from the Clearinghouse for Federal, Scientific, and Technical Information at about one-fifth the price of paper copies. Savings in storage space are even more dramatic. As a result of these studies it has been concluded that much of the transportation literature can be so stored. Cataloging is being done using appropriate computer programs. A plan is now under consideration to provide a duplicate set of fiche at another location on the campus to give added convenience to the users.

Cataloging

For cataloging the collection, the indexing is done in dome depth to provide access for as many subject viewpoints as seem necessary. A printed index is produced by computer using a program which manipulates the entires to provide access via author, subject descriptor, and Clearinghouse number. Other access points can also be provided. As this is a printed index, multiple copies can be printed and distributed to other libraries and researchers for desk side reference.

To promote a full utilization of the material in the collection, publicity in addition to the index should be developed. These might include an announcement bulletin of new items, bibliographies on specific

subjects, and a selective dissemination service which would automatically route particular items to an individual which correspond to his interest profile.

Cooperation With Other Agencies

Possibilities for cooperative efforts with other organizations are being explored through membership in a group of information specialists in the field of transportation, representing government agencies, academic institutions, research organizations, and private industry. Several projects are now being carried out such as the development of a standard thesaurus of descriptors, a union list of serials, and the groundwork for a cooperative indexing and abstracting program.

ACADEMIC PERSONNEL

The following pages contain the Vita of the Project director and other important faculty participants.

Daniel L. Gerlough

Date of Birth: May 31, 1916

Education: B.S. California Institute of Technology, 1937
M.S. Electrical Engineering, University of California, Berkeley, 1948
Ph.D. Engineering, University of California, Los Angeles, 1955

Professional Experience:

1937-1947 Varied industrial and consulting experience
1948-1959 University of California, Los Angeles
1948-1955 Assistant Research Engineer, Institute of Transportation and Traffic Engineering (ITTE) and Lecturer, Department of Engineering
1955-1956 Associate Research Engineer, ITTE and Lecturer, Department of Engineering
1956-1959 Associate Professor of Engineering and Associate Research Engineer, ITTE
1959-1963 Head, Traffic Systems Section, Thompson Ramo Wooldridge, Inc.
1963-1967 Manager, Traffic Systems Section Planning Research Corporation
1967-Present Professor of Transportation Engineering, University of Minnesota

Selected Publications:

Gerlough, D. L., "Simulation of Freeway Traffic by an Electronic Computer," Proceedings of Highway Research Board, 1956, Vol. 35, pp. 543-547.

Brenner, R., J. H. Mathewson, and D. L. Gerlough, "A General Method for Estimating Through Traffic in a Road Network," Highway Research Abstracts, September 1957, Vol. 27, No. 8, pp. 32-44.

Gerlough, D. L., "Control of Automobile Traffic--A Problem in Real-Time Computation," Proceedings of Eastern Joint Computer Conference, 1957, pp. 75-79.

Gerlough, D. L., "A Comparison of Techniques for Simulating the Flow of Discrete Objects," paper presented at the National Simulation Conference, Dallas, Texas, October 23-25, 1958.

Gerlough, D. L., "Applications of Computers to Traffic Problems," Proceedings of Institute of Traffic Engineers, 1958, Vol. 28, pp. 130-136.

Gerlough, D. L., and F. A. Wagner, "Simulation of Traffic in a Large Network of Signalized Intersections," paper presented at the Second International Symposium on Theory of Traffic Flow, London, England, June 25-27, 1963.

Wagner, F. A., Jr., Barnes, F. C., and Gerlough, D. L., Refinement and Testing of Urban Arterial and Network Simulation, PRC-R-1064, Report by Planning Research Corporation to U.S. Bureau of Public Roads, November, 1967.

Russell B. Adams

Date of Birth: January 1, 1926

Education: B.B.A. University of Minnesota, 1949 (Economics)
B.S. (Education) University of Minnesota, 1952
M.A. (Geography) University of Minnesota, 1955
Ph.D. (due June 1968) University of Minnesota; Geography major, Statistics, minor

Professional Experience:

1952-1953	High School Teaching (Math and Business), Hill City, Minnesota
1953-1957	Graduate Teaching Assistant and Lecturer (Geography and Social Science), University of Minnesota
1957	Observer, U.S. Government (CIA)
1957-1958	Program-Planner, Remington-Rand Univac, St. Paul
1958-1961	Ass't. Director, Twin Cities Area Transportation Study, Minnesota Highway Department
1961-1963	Ass't. Director, Urban Research Program, Upper Midwest Economic Study, Mpls.-St. Paul
1964-Present	Instructor and Ass't. Professor, Geography Department, University of Minnesota

Selected Publications:

"Work Program, 1960" TCATS, Minnesota Highway Department, 1960, St. Paul.

Manuals for TCATS Travel Survey, Minnesota Highway Department, 1959-61, St. Paul
a) Internal Home Interview
b) Truck/Taxi Survey
c) Coding-Data Processing Manual.

"A-F Tables," (Travel Survey), TCATS Report No. 19, Minnesota Highway Department, 1961, St. Paul.

"A Test of the Schneider (Opportunity) Model," TCATS Report No. 25, Minnesota Highway Department, St. Paul, March 1961, (with L. Wroblewski).

Trade Centers and Trade Areas of the Upper Midwest, Urban Research Program Report No. 3, Upper Midwest Economic Study, Minneapolis, 1963 (with J. Borchert).

Population Mobility in the Upper Midwest, Urban Research Program Report No. 6, Upper Midwest Economic Study, Minneapolis, 1964.

Projected Urban Growth in the Upper Midwest, 1960-1975, Urban Research Program Report No. 8, Upper Midwest Economic Study, Mpls., 1964 (with J. Borchert).

"Geographic Training and Urban Planning," Professional Geographer, May 1967 (with E. Maranda).

"Soviet Envoy Tells 'U' Prof of Peking Chaos," article in Minneapolis Tribune (Editorial Page), Dec. 30, 1967.

"Review of I. Lowry's 'Migration and Metropolitan Growth; two analytical models,'" Journal of Regional Science, Winter 1968.

"Recent Trends and Prospects in Water-Borne Commerce in the Twin Cities Area," Papers of the First Annual Water Transport Commerce, State Planning Agency, St. Paul, 1968.

"Social and Economic Profile," Chap. 3 in: St. Anthony Park Plan, St. Anthony Park Planning Commission, St. Paul, 1968.

"USSR Transportation," Focus (American Geographical Society, New York), 1968 (forthcoming, summer 1968).

"Migration Geography: A Methodological Inquiry and Case Study," Ph. D. thesis (forthcoming, June 1968), University of Minnesota, Department of Geography, Minneapolis.

SANT R. ARORA, Associate Professor

Biography

Dr. Arora received his B.S. and M.S. degrees in Mathematics at the University of Delhi and his Ph.D. in Operations Research at the Johns Hopkins University in 1962. He was employed at the Bell Telephone Laboratories for two years as a member of the technical staff. During his stay at the Bell Laboratories he worked on a number of systems engineering problems. Dr. Arora joined the University of Minnesota as an Assistant Professor in the Mechanical Engineering Department in the winter quarter of 1963. He was promoted to Associate Professor in the fall of 1965.

Representative Recent Publications

"Optimal Information Flow in an Organization," presented at the 18th National Conference of ORSA held in Houston, Texas, in November 1965.

"Optimal Collection of Money from Coil Boxes," published as a Technical Report of the Bell Telephone Laboratories.

"A Systems Approach to Water Supply and Sewage Disposal Problem in India," Proceedings International Seminar on Operations Research, New Delhi, India, August, 1967.

"Examining Costs in Solid Waste Disposal," Public Works Vol. 98, No. 10. October, 1967.

"Randomized Binary Search," Appearing in the Association of Computing Machinery in February, 1968.

"The Sequencing Problem" submitted to Management Science in March, 1967.

"Number of Potentially Optimal Sequences in a NXM Flow Shop Problem," Submitted to Management Science, April, 1968.

"Multi-Stage Sequential Decision Making in Investment Problems," Submitted to the Journal of Business, August, 1968.

"An Economic Model of underground Mining Systems," Submitted to the Journal of Industrial Engineering, July, 1968.

"Computerized Control of Combined Sewage Overflow," Submitted to Journal of Water Pollution Control Federation, April, 1968.

Current Research

Currently involved in optimal production control problems of multi-item production line systems. He has a research grant from the Office of International Programs of the University of Minnesota for studying the optimal development of Petro-Chemical Sector in India. He is also currently working on developing a systems analysis model for water and related land resources planning in Minnesota. He is also engaged in the optimal flow problems in a hospital.

JOHN EDWARD ANDERSON
Associate Professor of Mechanical Engineering
University of Minnesota

Formal Education

BSME	Iowa State College, 1949
MSME	University of Minnesota, 1955
Ph.D.	M.I.T. Department of Aeronautics and Astronautics, 1962

Professional Experience

1949-1951 Aeronautical Research Scientist, NACA, Langley Field, Va. Developed methods of analysis of stresses and deflections in delta wings. Experience with high-speed electronic computation. NACA Report 1131, 1953.

1951-1959 Honeywell, Inc., Aeronautical Division

1951-1954 Development Engineer, Work Director. Developed and designed components of aircraft fuel measurement systems, U.S. Patents 2,2824,270; 2,916,679. Product-of-the-month Award, Aviation Age, May, 1953.

1954-1955 Senior Research Engineer. Analysis and synthesis of military aircraft autopilot systems via analog computer and other techniques.

1955-1956 Research Project Engineer, Technical director of analytical work on F100 and F107 autopilot systems, U.S. Patent 2,944,203.

1956-1957 Research Project Engineer, Inertial Guidance. Invented and led development of gimballess inertial system, and novel ballistic missle guidance system. U.S. Patent 3,011,350.

1957-1958 Principal Research Engineer. Consultant on inertial navigation, control, dynamics and vibration engineering, led proposed efforts, lectured on inertial navigation to customers in government and industry, directed project to develop master reference system for Polaris submarine which led to major contract.

1958-1959 Research Staff Engineer. Proposal work, led large department-wide program for development of gimballess inertial system which led to contract.

1959-1962 M.I.T. Fellow in Aeronautics and Astronautics. Ph.D. Thesis: "Magnetohydrodynamic Shock Waves," M.I.T. Press, 1963.

1962-1963 Staff Consultant, Manager of Space Systems. Staff studies on laser effects, high-power laser, magneto-hydrodynamic ststems. Technical Director of large preliminary design study of Solar Probe Spacecraft which led to first corporate space-systems contract.

1963-present Associate Professor, Mechanical Engineering Department

1963-1967 Taught magnetohydrodynamics, thermodynamics, heat transfer, design. Research in magnetogasdynamics of electric arcs involving numerical solution of partial differential equations CDC 1604, 6600. Consultant to industry in spacecraft systems, explosion dynamics, magneto- and electrohydrodynamics, inertial systems.

1967-1968 National Academy of Sciences Exchange Professor in the Soviet Union

1968-present Major portion of research time devoted to latent interests in urban mass transit systems.

Member of Tau Beta Pi, Pi Tau Sigma, Phi Kappa Phi, Eta Kappa Nu, Sigma Xi. Registered Professional Engineer, Vice Chairman, Twin Cities Section, AIAA. Within DOT, professional capabilities known to Mr. Charles Baker, 962-5555.

Representative Recent Publications

"Transpiration Cooling of a Constricted Electric-Arc Heater," (with E.R.G. Eckert). AIAA J. Vol. 5, No. 4, pp. 699-706. April, 1967.

"The Inverse Problem in Arc Physics," Phys. of Fluids, Vol. 10, No. 4, pp. 894-896. April, 1967.

"Local Temperature Variations of a Transpiration-Cooled Wall Due to Radiant Heating," J. Heat Transfer, Vol. 90, pp. 146-150. Feb. 1968.

Magnetogasdynamics of Thermal Plasma. To be published by Massachusetts Institute of Technology Press (in Press).

"A Numerical Method to Compute the Distribution of Temperature and Current Density in a Constricted Electric-Arc Heater with Known Velocity Profiles," (with D.K. Hennecke). HTL TR NO. 77. Sept. 1967.

"Difference Equations for the Solution of Axisymmetric Problems in Steady Flow of Gases with Variable Properties and with Electric Heat Addition," HTL TR NO. 80, February, 1968.

Resume

Frederick J. Beier
Assistant Professor of Transportation and Logistics
Graduate School of Business Administration
University of Minnesota

Home Address: 4504 First Avenue South
Minneapolis, Minnesota 55409
822-1273

Birth Date: November 15, 1938, Chicago, Illinois

Marital Status: Married, Three Children

Education: Ph.D. (Business Logistics), The Ohio State University, Columbus, Ohio 1969

M.B.A., The Ohio State University, 1964

B.S. The Ohio State University, 1962

Positions: Assistant Professor, Graduate School of Business Administration, University of Minnesota, 1969-Present

Instructor, 1968-1969

Assistant Director, Graduate Business Programs, The Ohio State University, 1967-1968

N.D.E.A. Fellow in Business Logistics, The Ohio State University, 1963-1967

Professional Memberships: Transportation Research Forum
American Marketing Association

Recent Publication:

"The Role of the Common Carrier in the Channel of Distribution," Transportation Journal, Winter, 1969

"Sources and Uses of Power in the Channel of Distribution," (coauthor), to be published as part of a readings book edited by L. Bucklin by Scott Foresman.

"Power in the Channel of Distribution," in L. Stern, ed., Marketing Channels: Behavioral Dimensions (Boston: Houghton Mifflin, 1969).

John R. Borchert

Education

B.A., DePauw University, 1941.
M.A., University of Wisconsin, 1946, Ph.D., 1949.

Professional Experience

Instructor, University of Wisconsin, 1947-49.
University of Minnesota, 1949 - Present.
Assistant Professor, 1949-51.
Associate Professor, 1951-56.
Professor, 1956 - Present.
Chairman, Department of Geography, 1956-61.
Project Director (with Professor Philip M. Raup), Minnesota Highway Research Project, 1958-61.
Urban Research Director, Upper Midwest Economic Study, 1961-63.
Associate Dean, Graduate School, and Professor of Geography, winter-spring, summer, 1965.
Special Assistant to the Vice President for Educational Relationships and Development, 1966-68.
Director, Center for Urban and Regional Affairs, 1968 - Present.

Professional Membership

Association of American Geographers
American Institute of Planners
American Association of University Professors
National Council for Geographic Education
Urban Land Institute

Professional Service

Member, Social Sciences Advisory Committee, National Science Foundation, 1966 - Present.
Chairman, Earth Sciences Division, National Research Council, 1967-69.
Vice President, Association of American Geographers, 1967-68.
President, Association of American Geographers, 1968-69.

Consultant To:

Environmental Research Division, Office of the Quartermaster General, 1959-55.
Minnesota Highway Department, 1954, 1958.
St. Paul Planning Board, 1957-58.
Hennepin County (Minneapolis area) Highway Department, 1956.
Minnesota Board of Education, intermittently.
St. Paul Board of Education, intermittently.
Minnesota Natural Resources Council, 1962.
Minnesota Outdoor Recreation Resources Commission (standing committee of the legis.), 1964, 1966-67.
St. Paul Housing and Redevelopment Authority, 1965-66.
Senate Highway Committee, Minnesota Legislature, 1966.
U.S. Department of Commerce, Economic Development Administration, Regional Economic Development Institute, Summer, 1967.
Minnesota State Planning Agency, 1966-67.
National Science Foundation, Division of Social Sciences.

Selected Publications

"Time Series Maps for the Projection of Land-Use Patterns" (with Donald D. Carroll), 40th Annual Highway Research Board Meetings, Bulletin 311, Washington: National Academy of Sciences-National Research Council, 1961, pp. 13-26.

"Minnesota Municipalities: 1975 Projections and Possibilities," Minnesota Municipalities, (49) 1964, pp. 236-239, 257.

"Summary of Economic and Geographic Trends and Problems in the Upper Midwest," Nation's Manpower Revolution. (Transcript of Hearings, Subcommittee on Employment and Manpower, Committee on Labor and Public Welfare, U.S. Senate), Washington: U.S. Government Printing Office, November 1963, pp. 2381-2387.

Projection of Population and Highway Traffic in Minnesota. Minneapolis: University of Minnesota Highway Research Project, 1963, 42 pages, maps.

The Urbanization of the Upper Midwest: 1930-1960. Minneapolis: Upper Midwest Economic Study Urban Report No. 2, 1963, 56 pp., maps.

Trade Centers and Trade Areas of the Upper Midwest (with Russell B. Adams), Minneapolis: Upper Midwest Economic Study Urban Report No. 3, 1963, 44 pp., maps.

The Why and How of Community Planning (with Thomas L. Anding, Donald V. Klein, Ellis Waldron, and C. Lee Gilbert), Minneapolis: Upper Midwest Economic Study Urban Report No. 4, 1963, 47 pp., maps.

"Geography and Systems Theory," Chapter 18 in Saul B. Cohen (ed.), Problems and Trends in American Geography, New York: Basic Books, 1967, pp. 264-273.

JOHN EDWARD BRANDL

Vita

Age: 32 (born August 19, 1937)

Married to the former Rochelle Ann Jankovich, December 29, 1960; three children.

Education:

Early Education:	St. Cloud, Minnesota, 1943-1955.
College:	St. John's University, Collegeville, Minnesota, 1955-1959. B.A. 1959 (economics).
Honors:	4 year scholarship from St. John's University--graduated with honors.
Graduate School:	Harvard University, Cambridge, Massachusetts, 1959-1963. M.A. 1962. Ph.D. 1963 (economics).
Honors:	2 year post-graduate fellowship from St. John's University--Teaching Fellowship--Staff Tuition Scholarship--H.B. Earhart Senior Fellowship.

Other Honors and Activities:

Received the Joint Service Commendation Medal from Secretary of Defense, Robert McNamara, 1965.

Member, Board of Directors, Tri-Cap, Inc. (a Tri-County Community Action Program in Central Minnesota) 1966-67.

Elected to Delta Epsilon Sigma national honor society, 1967.

Named one of the Outstanding Young Men of America, by U.S. Junior Chamber of Commerce, 1967.

Elected to Council of Directors, Catholic Economic Association, 1968.

Professional Experience (in inverse chronological order):

September 1969-
Director, School of Public Affairs, University of Minnesota.

September 1968-August 1969
Deputy Assistant Secretary for Education Planning, Department of Health, Education and Welfare, Washington, D.C. (on leave from the University of Wisconsin).

Summer 1968-
Visiting Lecturer, Department of Economics, University of the Philippines (under the sponsorship of the Ford Foundation).

August 1967-June 1968
Assistant Professor, Department of Economics, University of Wisconsin.
Director of Educational Program in Systematic Analysis (a graduate program for federal government employees), University of Wisconsin.
Research Associate, Institute for Research on Poverty, University of Wisconsin.

September 1965-September 1968
Consultant to: Office of the Secretary of Defense; Department of Health, Education and Welfare; Department of Commerce; Office of Economic Opportunity; Civil Service Commission; Operations Research, Inc.; Department of Administration, State of Wisconsin.

September 1965-July 1967
Assistant Professor, Department of Economics, St. John's University, Collegeville, Minnesota.

Summer 1966-
Consultant, Economic Development Administration, Department of Commerce, Washington, D.C.

June 1963-August 1965
Systems analyst, Office of the Secretary of Defense, (this position was held in liew of serving a two year obligation as an Army lieutenant).

September 1962-June 1963
Teaching Fellow, Harvard University (taught in the College and the Graduate School of Arts and Sciences).

September 1961-June 1962
Lecturer, Department of Economics, Boston College (taught in the College and the Graduate School of Arts and Sciences).

Publications:

"World Views in the Social Sciences," The Current, October 1962.

Damage Limiting: A Rationale for the Allocation of Resources by the U.S. and the U.S.S.R., 1964 (a classified monograph in the Office of the Director of Defense Research and Engineering, co-author with Glenn A. Kent and Lee Q. Niemela).

"On Budget Allocation in Government Agencies," Review of Social Economy, March 1967.

Book Reviews in the Review of Social Economy, March 1962 and March 1967.

"On the Treatment of Incommensurables in Cost-Benefit Analysis," Land Economics, November, 1968.

"The Goals-Achievement Matrix: A Comment," Journal of the American Institute of Planners, forthcoming.

Comment on Estimation of Educational Production Functions (to be published in proceedings of an NBER Conference on Education and Income, held in Madison, Wisconsin, November 1968).

Program Memorandum on Education (Office of Planning and Evaluation, Department of Health, Education, and Welfare, September 1969. My staff deserves most of the credit for this document.)

"Education Program Analysis at HEW" (for a Joint Economic Committee Compendium on Analysis and Decision-Making in the Federal Government for Spring 1969 publication)

Completed Research:

The Early Development of Econometric Method (Unpublished Ph.D. thesis, 1963).

"Constrained Maximization and Decision Rules in Government: An Analysis of An Investment Allocation Formula," (submitted to Philippine Economic Journal, 1968).

Research in Progress:

"The Argument for Regressivity in a Negative Income Tax."

"Alternative Formulas for Fiscal Sharing."

Biography

Dr. Frohrib received his Bachelor's and Master's degrees in Mechanical Engineering from the Massachusetts Institute of Technology in 1952 and 1953, specializing in applied mechanics and machine design. He received his Ph. D. in Aeronautics and Engineering Mechanics from the University of Minnesota. From 1953 to 1959, Dr. Frohrib was employed at Sperry Gyroscope Company, Long Island, New York, as a group leader in shock and vibration analysis. His responsibilities were in design optimization of defense systems and electro-magnetic devices in shock and vibration environments and in the development and application of shock and vibration instrumentation. Dr. Frohrib teaches dynamics and design in the Design Division of the Mechanical Engineering Department. He also serves as consultant in stress and dynamics analysis to the Univac Division of Sperry Rand Corporation. Dr. Frohrib's research interests are in the design and analysis of systems subjected to dynamic environments, the synthesis of mechanism systems, and in computer solutions of optimization problems in engineering design. He coordinates the Interdepartmental Engineering Design Program in the Departments of Mechanical Engineering, Aeronautics and Engineering Mechanics, and Civil Engineering. The development of a learning center in Socio-Technological Design under the auspices of the Council on Liberal Education is one of his current educational interests.

Representative Recent Publications

"The Optimum Design of Fire-Ply Viscoelastic Isolation Flexures for Point nertia Loading." Proceedings of the 38th Symposium on Shock and Vibration, Dept. of Defense, St. Louis, Missouri, May 1, 1968.

"The Free Vibrations of Stiffened Drill Strings With Static Curvature" (with R. Plunkett). Journal of Engineering for Industry, American Society of Mechanical Engineers, Paper No. 66-Pet. 1.

"The Effect of Inertia Variation and Certain Asymmetries on the Dynamic Response of An Elastically-Coupled System," presented at the 35th Symposium on Shock and Vibration, Dept. of Defense, New Orleans, La., October 26, 1965.

"Designing Flexible Beam Suspensions." Machine Design, July 6 and July 20, 1961.

Current Research

1. Shock and Vibration Design
2. Optimization in Engineering Design in the area of applied mechanics
3. The Synthesis of Mechanisms
4. The Effects of Flexibility in Spatial Mechanisms
5. Optimization of Flexural Strain Energy

PROFESSIONAL BIOGRAPHY

Donald Victor Harper
Professor of Transportation and Logistics
Graduate School of Business Administration
University of Minnesota
Minneapolis, Minnesota 55455
Phone: 373-3589

Home Address: 2451 North Sheldon Street
St. Paul, Minnesota 55113
Phone: 633-7368

Birth Date: March 27, 1927 Birth Place: Chicago, Illinois

Marital Status: Married, three children

Military Service: United States Navy, April, 1945 - June, 1946

Education: Ph.D. (Economics), University of Illinois, Urbana, Illinois, 1957
B.S. University of Illinois, Urbana, Illinois, 1950
Wright Junior College, Chicago, Illinois, three semesters in 1944 and 1946-1947.

Positions: Professor, Graduate School of Business Administration, University of Minnesota, 1965-present; Chairman, Department of Management, Production, and Transportation, 1967-present; Associate Professor, 1959-1965; Assistant Professor, 1956-1959; Lecturer, July, 1956-December, 1956
Instructor in Economics (part time), College of Commerce, University of Illinois, 1953-1956
Sales Department, General Mills, Inc., Chicago, Illinois, 1950-1952
Practitioner before the Interstate Commerce Commission
Consultant to private business firms

Professional Memberships:

American Economic Association
Transportation Research Forum
Transportation Club of St. Paul
Northwest Shippers Advisory Board
Traffic Club of Minneapolis
Association of Interstate Commerce Commission Practitioners
Railway Systems and Management Association
American Marketing Association

Research and Publications Completed and in Progress (as of July, 1968)

Books

Economic Regulation of the Motor Trucking Industry by the States, University of Illinois Press, Urbana, Illinois, 1959. (Expansion of Ph.D. dissertation.)

Economic Guidelines for Unemployment Insurance, Minnesota: 1958-67 (with George Seltzer and Others), Minnesota Department of Employment Security, 1959. (Report of study concerning an examination of Minnesota's unemployment insurance program.)

Price Policy and Procedure, Harcourt, Brace, and World, Inc., New York, 1966. (Text for use in marketing courses in price policy and in marketing management courses in which pricing is an important part.)

Monographs

Basic Planning and the Transportation Function in Small Manufacturing Firms, Small Business Management Research Report, School of Business Administration, University of Minnesota, January, 1961. (Report based on research involving 38 personal interviews with small manufacturers in Minnesota relative to their handling of the transportation function.)

Opportunities and Problems for Small Business in Foreign Trade Via the St. Lawrence Seaway (with E. A. Nightingale), Small Business Management Research Report, School of Business Administration, University of Minnesota, November, 1964. (Report based on research involving 1,250 mail questionnaires returned from business firms in the nine-state area covered by the study relative to the nature of foreign trade and the use and potential use of the St. Lawrence Seaway for such trade.)

Marketing Advances (editor), proceedings of 9th Biennial Marketing Institute, Minnesota Chapter, American Marketing Association, November, 1963.

Articles

"Wholesale Trade in Minnesota" (with R. J. Holloway), Greater Minneapolis (centennial issue), January, 1958.

"The Shipper Views Economic Regulation of For-Hire Trucking," Inter-State Commerce Commission Practitioners' Journal, December 1963. (Article based on a study involving ninety-two personal interviews with and mail questionnaires received from industrial traffic managers in Minnesota and Wisconsin relative to their reaction to government economic regulation of the for-hire trucking industry.)

"Transportation: A Forgotten Function of Marketing," Boston University Business Review, Spring, 1964. (Article which deals with the relationship between marketing and transportation (and physical distribution management) in marketing practice and in marketing education.)

"What Next for Transportation Education?" The Transportation Journal, Spring, 1965. (Article which deals with the present status of transportation education in collegiate schools of business administration and developments to be expected and to be encouraged in the future.)

"Economic and Managerial Aspects of State Taxation of Commercial Airlines" (with N. A. Glaskowsky, Jr.). The Transportation Journal, Winter, 1965. (Aritcle which deals with the economic implications of and managerial problems associated with specialized state taxes on the commercial airline industry.)

The following articles appeared in Business News Notes, published by the School of Business Administration, University of Minnesota:

"The Changing Pattern of Minnesota's Retail Trade" (with R. J. Holloway), March, 1957.

"The Wholesale and Service Trades of Minnesota" (with R. J. Holloway), July, 1957.

"Transportation Trends in Minnesota," April, 1959.

Book Reviews

A. J. Bergfeld, J. S. Earley, and W. R. Knobloch, Pricing for Profit and Growth. Reviewed in the Journal of Marketing, October, 1958.

James C. Nelson, Railroad Transportation and Public Policy. Reviewed in the Journal of Marketing, July, 1960.

Roy J. Sampson and Martin T. Farris, Domestic Transportation: Practice, Theory, and Policy. Reviewed in the Journal of Marketing, January, 1967.

Martin T. Farris and Paul T. McElhiney, Modern Transportation: Selected Readings. Reviewed in the Journal of Marketing, April, 1968.

Matthew J. Huber

Date of Birth: September 10, 1924

Education: B.C.E. Marquette University, 1945
M.S.C.E. Michigan State University, 1950
Certificate in Highway Traffic Yale University Bureau of Highway Traffic, 1953
M of E Yale University, 1965
Ph.D. Yale University, 1968

Professional Experience:

1945-1946	U. S. Marine Corps.
1946-1948	City of Milwaukee and Wisconsin State Highway Department
1948-1953	Instructor and Ass't. Prof. - Michigan State Department of Civil Engineering
1955-1968	Research Associate Bureau of Highway Traffic, Yale University
1968 (September)	Associate Professor of Transportation Engineering, University of Minnesota

Selected Publications:

"Control of Access to Roads and Streets" Proceedings of the Fortieth Annual Highway Conference, University of Michigan, 1955.

"Effect of Temporary Bridge on Parkway Performance" Highway Research Board, Bulletin 167, 1957.

"Measuring Lateral Placement and Velocity" (co-author with P. H. Thompson) Traffic Engineering, Vol. 31, No. 1, October, 1960.

"Traffic Operations and Driver Performance as Related to Various Conditions of Nighttime Visibility" Highway Research Board, Bulletin 336, 1962.

"Street Travel as Related to Local Parking" Proceedings, Highway Research Board, Vol. 41, 1962.

"Computer Programming for Traffic Problems and Flow Characteristics" in Traffic Control Theory and Instrumentation, ed. by Thomas R. Horton, Plenum Press, New York (1965).

"Traffic Characteristics" in forthcoming text on Highway Traffic Engineering (to be published by Automotive Safety Foundation - Spring 1968).

"Effect of Illumination on Operational Characteristics of Freeways" (co-author with Joseph L. Tracy) (to be published by National Cooperative Highway Research Program - Spring, 1968).

"Predicted Traffic Usage of a Major Highway Facility Versus Actual Usage" (co-author with Harvey B. Boutwell, David K. Witheford) (to be published by National Cooperative Highway Research Program - Spring, 1968).

WARREN E., IBELE, Professor

[illegible]

W. Ibele received his B.S. degree in Mechanical Engineering from [illegible] University (1944). Following active duty (U.S. Navy 1944-46) he undertook graduate study at the University of Minnesota receiving a M.S. (1947) and Ph.D. (1953) in Mechanical Engineering. Dr. Ibele has served as Assistant Project Engineer with the Technical and Research Group of Pratt and Whitney Aircraft at intervals for the period 1955-58. He is co-author of Engineering Thermodynamics (1960) a textbook, and editor of Modern Developments in Heat Transfer (1963). He is the author of a number of papers in the area of thermodynamics, transport properties, fluid mechanics, heat and mass transfer. Dr. Ibele is presently Professor of Mechanical Engineering.

Representative Recent Publications

"Prandtl Number Measurements and Transport Property Calculations for N_2 - CO_2 Mixtures," (with D. G. Briggs). Pages 392-97 in Proceedings of the Fourth Symposium on Thermophysical Properties. (Editor : J. R. Moszynski). New York: The American Society of Mechanical Engineers, 1968.

"Interface Resistance and Stability in Laminar Film Condensation Heat Transfer," (with D. L. Spencer). JSME 1967 Semi-International Symposium, Tokyo, September 4-8, 1967, in Heat and Mass Transfer, Thermal Stress, Vo. II, pp. 99-104. The Japan Society of Mechanical Engineers, Tokyo.

"Experimental Anode Heat-Transfer Studies in a Coaxial Arc Configuration," (with K. T. Shih, E. Pfender, and E. R. G. Eckert). AIAA J. Vol. 6, No. 8, pp. 1482-87, August, 1968.

Current Research

Investigation of thermodynamic and transport properties of gases and gas mixtures by experiment and theory.

1) Gas viscosity measurements by means of porous plug.

2) Local heat transfer on vertical plate in natural convection in presence of turbulence promoters.

3) Diffusion coefficient and thermal diffusion factors for binary gas systems determined from measurement of temperature and concentration profiles.

4) Steady state-hot-wire cell for gas thermal conductivity determination of gases and gas mixtures.

5) Theoretical studies including statistical thermodynamic investigation of transport properties of pure gases and gas mixtures, and irreversible thermodynamics.

6) Measurements in pipe flow - with orifices.

Resume

Name: K.S.P. Kumar

Date of Birth: May 12, 1935

Address: Department of Electrical Engineering, University of Minnesota, Minneapolis, Minnesota 55455

Telephone: 373-5228

Educational Background:

B.Sc.	Mysore University, India	1953
M.Sc. (Physics)	Karnatak University, India	1955
D.I.I.Sc. (Electrical Communication Engineering)	Indian Institute of Science, India	1958
M.S.E.E.	Purdue University, U.S.A.	1961
Ph.D.	Purdue University, U.S.A.	1964

Work Experience:

1967 -	Associate Professor, Dept. of Elec. Eng., University of Minnesota, Minneapolis, Minnesota, U.S.A.
1964 - 1967	Assistant Professor, Dept. of Elec. Eng., University of Minnesota, Minneapolis, Minnesota, U.S.A.
1964	Post Doctoral Research Fellow, School of Electrical Engineering, Purdue University, Lafayette, Indiana, U.S.A.
1964 (summer)	Engineering Specialist, Applied Research Laboratory, Sylvania, Waltham, Massachusetts, U.S.A.

1963	Instructor, School of Electrical Engineering, Purdue University, Lafayette, Indiana, U.S.A.
1962 (summer)	Senior Research Engineer, Honeywell, Minneapolis, Minnesota, U.S.A.
1961 (summer)	Visiting Scientist, Research Institute for Advanced Studies (RIAS), Baltimore, Maryland, U.S.A.
1961 - 1963	Fellowship of the Purdue Research Foundation, Purdue University, Lafayette, Indiana, U.S.A.
1959 - 1961	Graduate Teaching Assistant, School of Electrical Engineering, Purdue University, Lafayette, Indiana, U.S.A.
1958 - 1959	Technical Assistant, Department of Electrical Communication Engineering, Indian Institute of Science, Bangalore, India.

Consulation Experience:

1965	General Mills, Inc., Minneapolis, Minnesota
1964 - 1967	UNIVAC, Aerospace Analysis Group, St. Paul, Minnesota
1967	3M Company, St. Paul, Minnesota

Committee Assignments:

1969	Director of Undergraduate Education in Electrical Eng
1968	Director of Graduate Studies and Fellowship Affairs in Control Sciences
1969	Chairman of the Undergraduate Curriculum Studies

Publications:

1. On the Space Charge Limited Current-Flow from a Cylindrical Cathode to a Pair of Parallel Plane Anodes (Co-authored with S. Sampath), Electrotechnics, No. 26, pp. 74-80, 1959.

2. A New R.M.S. Describing Function for Single-Valued Nonlinearities (Co-authored with J.E. Gibson), Proc. of I.R.E., Vol. 49, No. 8, p. 1321, August 1961.

3. Statistical Design of Discrete Data Control Systems Subject to a Power Limitation (Co-authored with J.T. Tou), J. of Franklin Institute, Vol. 272, No. 3, pp. 171-184, September 1961.

4. On the Identification of Control Systems by the Quasilinearization Method, (Co-authored with R. Sridhar) IEEE Trans. on Automatic Control, April 1964.

5. Editor of "Modern Aspects of Automatic Control", published by School of Electrical Engineering, Purdue University, 1963.

6. On Combined Identification and Control (Co-authored with R. Sridhar), January 1964, IEEE Trans. on Automatic Control, Correspondence.

7. On the Identification of Control Systems (Co-authored with R. Sridhar), JACC, Stanford, 1964.

8. On the Utilization of Digital Computers in Control Systems, Advances in Control Systems, University of Wisconsin, Madison, Wisconsin, 1964.

9. On the Identification of Nonlinear, Nonstationary Processes, IFAC Tokyo Symposium, Tokyo, Japan, August 1965.

10. On the Optimum Stabilization of a Satellite, IEEE Trans. on Aerospace and Electronic Systems, Vol. AES 1, No. 2, pp. 82-83, October 1965.

11. Discrete Differential Approximation, Proc. IEEE (Correspondence), Vol. 54, No. 1, pp. 64-65, January 1966.

12. On a Fixed End Point Regulator Problem, IEEE Trans. on Automatic Control, Vol. AC-11, No. 2, p. 310, April 1966.

13. Stabilization of a Satellite Via Specific Optimum Control (Co-authored with L. Teng), IEEE Trans. on Aerospace and Electronic Systems, Vol. AES-2, No. 4, pp. 446-449, July 1966.

14. Optimum Control for Lunar Soft Landing (Co-authored with L. Teng), 17th International Astronautical Congress, Madrid, Spain, October, 1966.

15. Sensitivity Considerations in Specific Optimum Control (Co-authored with R.J. Burns), Int. Journal of Control, Vol. 5, No. 3, pp. 289, 296, 1967.

16. Discrete Differential Approximation and System Identification, Int. Journal of Control, Vol. 6, No. 1, pp. 27-32, 1967.

17. Synthesis of Suboptimal Feedback Controls for a Class of Distributed Parameter Systems (Co-authored with J.H. Seinfeld), Int. Journal of Control, Vol. 7, No. 5, pp. 917-924, 1968.

18. Successive Linearization and Nonlinear Filtering (Co-authored with S. Kau), 2nd International Conference on Optimization Theory, San Remo, Italy, 1968.

19. Satellite Attitude Determination via Nonlinear Filtering (Co-authored with S. Kau, G. Granley), IEEE Trans. Aerospace and Electronic Systems, Vol. AES-5, No. 6, pp. 906-911, November, 1969.

20. Successive Linearization and Nonlinear Smoothing (Co-authored with S. Kau) Int. Journal of Control, 1969.

21. Sensitivity Analysis of Nonlinear Estimation Algorithms (Co-authored with R. Joisa) National Electronics Conference, Chicago, December 1968.

22. Attitude Estimation: An Experimental Analysis (Co-authored with R. Joisa) 2nd IFAC Symposium on Identification, Prague, Czechoslovakia, 1970.

DEPARTMENT OF ECONOMICS
UNIVERSITY OF MINNESOTA
MINNEAPOLIS, MINNESOTA 55455

Name: James Dean Likens

Address: 3933 Bryant Ave. So.
Minneapolis, Minnesota 55409
Tel 612-825 5061

Office: Department of Economics
University of Minnesota
Tel 612-373-4386

Age: 31

Marital Status: Married

Citizenship: U. S.

Military Service: Completed

Education:

1960 AB, Economics (with honors), University of California (Berkeley)
1961 MBA, Bus. Admin. (Marketing), University of California (Berkeley)
1963-date, University of Minnesota, Ph.D. candidate

Thesis Topic:

"The Welfare Costs of Non-optimal Airport Utilization: A Case Study of the Washington-Baltimore Airports"

Thesis Adviser:
Professor Herbert D. Mohring

Expected Date of Ph.D. Degree:
June 1968

Major Fields of Interest:

Economic Theory, Industrial Organization, Labor Economics

Minor Fields of Interest:

Comparative Systems, Soviet Economics, Money & Banking
History of Economic Thought, Business Administration (Marketing)

Honors: CLA Tuition Scholarship
Cited for excellence in teaching, university-wide course evaluation

Experience:

1960-61, Research Assistant, Univ. of Calif. (Berkeley), leading to Lee E. Preston, "Markups, Leaders, and Discrimination in Retail Pricing" Journal of Farm Economics, May 1962.

1962-63, Economic & Market Research Analyst, Del Monte Food Corporation, prepared company and industry position on Trade Exmansion Act and Kennedy Tariff Round.

1963-64, assisted in writing Harlan Smith, ed., Study Guide for Selected Sixty Session Series of The American Economy TV Films, Joint Council on Economic Education, 1964.

1963-64, Instructor, Wisconsin State University (Course: Economic History of the United States).

1964-65, Marketing Research Analyst, Stephen K. Plasman & Associates, (consultants), Minneapolis.

1967-68, consulted for Minnesota Mining and Manufacturing Company, writing unpublished (proprietary) economic analysis of the air transport industry (269 pages).

1964-date, Instructor, University of Minnesota (Courses: Principles of Economics, Intermediate Micro Theory, Industrial Organization).

References: (all professors of economics, University of Minnesota)
Herbert D. Mohring (Adviser), Peter Gregory, E Scott Maynes, Edward Coen, John Buttrick (Director of Graduate Studies), Norman Simler (Chrm.)

Herbert Mohring

Date of Birth: September 8, 1928

Education: A. B. Williams College, 1950, Economics, Mathematics
Ph.D. Massachusetts Institute of Technology, 1959, Economics

Professional Experience:

1951-1952	Research Associate; University of Michigan; Willow Run Research Center
1952-1954	Teaching Fellow; M.I.T.; Department of Economics
1954-1957	Assistant Study Director, Study Director, University of Michigan, Survey Research Center
1957-1958	Research Associate; Resources for the Future, Inc.
1958-1961	Research Economist; Transportation Center at Northwestern University
3-7/1961	Consultant; Northwestern University, Department of Economics, Economic Survey of Liberia
1961-1967	Associate Professor; Department of Economics, University of Minnesota
1967-Present	Professor, Department of Economics, University of Minnesota

Selected Publications:

Highway Benefits: An Analytical Framework, Evanston: Northwestern University Press, 1962 (joint author with Mitchell Harwitz).

"Land Value and the Measurement of Highway Benefits," Journal of Political Economy, June 1961.

"The Place of Subsidies in an Optimum Transportation System," Highway Research Record, Number 20,1963.

"Urban Highway Investments," in Robert Dorfman, Editor, Measuring Benefits of Government Investments. Washington: Brookings Institution 1965, pp. 231-275, 288-291.

"The Relation Between Optimum Congestion Tolls and Present Highway User Charges," Highway Research Record, No. 47, (1964), pp. 1-14.

Transportation Economics, New York: Random House (forthcoming).

DEPARTMENT OF ECONOMICS
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MINNEAPOLIS, MINNESOTA 55455

Name: Thomas Pinfold

Age: 28

Address: 3423 - E. 26th Street
Minneapolis, Minnesota 55406
Tel: 612-724-4845

Marital Status: Married

Citizenship: Canadian

Office: 304 Center for Economic Research
University of Minnesota
Tel: 612-373-5553

Education:

1963, B.A., Economics - University of Western Ontario
1965, M.A., Economics - University of Western Ontario
1965-present, University of Minnesota, Ph.D. candidate

Thesis Topic:

"The Modal Split Problem in Urban Transportation"

Thesis Adviser:

Professor Herbert Mohring

Expected Date of Ph.D. Degree:

June 1969

Major Fields of Interest:

Economic Theory, International Trade, Econometrics

Minor Fields:

Mathematics, Statistics

Experience:

Teaching

Teaching Assistant at Western Ontario: 1963-64, 1965-65, responsible for conducting two tutorial sessions per week for 10-15 students, which involved lectures on particular problems to amplify the professor's lectures and answering student questions about home problems and exams.

Teaching Assistant at Minnesota: 1966-67, assisted Professor John Buttrick with a senior undergraduate course in Welfare Economics; in addition to grading, I was responsible for class discussion of examinations and home problems.

Research

Research Assistant at Western Ontario: Summer 1965 for Professor G. L. Reuber; duties consisted of compiling articles on Canada in the international economy for a book of readings edited by Professor Reuber and Professor H. E. English to be published in The Carleton Library series.

Research Assistant at Minnesota: 1965-68 to Professor Herbert Mohring in various research projects. Through this period my responsibilities included (1) developing quantitative evidence on the relative importance of alternative inputs in the petroleum refining industry; and, generating evidence on the importance of tariff structure for petroleum and petroleum products as it affects production location in the US petroleum refining industry; (2) independent development and checking of mathematical models to be used for computer simulation in welfare loss problems and deriving quantitative estimates of the benefit measures for specific examples; (3) developing evidence of the impact of collusion in the rock salt industry on the price of rock salt through analysis of the geographical price structure in the state of Minnesota.

Some results of this work may be found in: Herbert Mohring, Marvin Kraus and Thomas Pinfold, "The Welfare Costs of Non-Optimal Pricing and Investment Policies for Urban Freeways," February, 1969. Other results are contained in Professor Mohring's recent and near future publications.

As a by-product of the project on the welfare costs of non-optimal pricing and investment policies, I transalted, Marcel Boiteux, "Sur la Gestion des Monopoles Public Astreints à l Equilibre Bugetaire," Econometrica, January, 1956, pp. 22-40. I expect this article will appear in a book of translated articles in preparation by Professor John Chipman.

Fellowships:

Ontario Graduate Fellowship 1964-65 (1965-66 Awarded, but declined)
Canada Council Doctoral Fellowship 1968-69

References:

Professor Herbert Mohring
Department of Economics
University of Minnesota

Professor John A. Buttrick
Department of Economics
University of Minnesota

Professor Clifford Hildreth
Department of Economics
University of Minnesota

Thomas M. Scott

Education: B.A. College of Wooster, 1959
Ph.D. Northwestern University, 1964

Professional Rank: Associate Professor of Political Science, University of Minnesota

Selected Publications:

"Election Legislation," Book of the States, 1968-69, Chicago, Council of State Governments, 1968, 19-22.

"Metropolitan Governmental Reorganization Proposals," Western Political Quarterly, Vol. 21, No. 2, June, 1968, pp. 252-261.

"The Diffusion of Urban Governmental Forms as a Case of Social Learning," Journal of Politics, forthcoming, November, 1968, about 12 pages.

ADMINISTRATION AND ORGANIZATION

See Pages 10 - 17.

BUDGET

The sheet which follows gives budget estimates for the various categories for a three-year program. Some items for the second and third years are estimated on a gross basis. Following sheets give breakdowns by projects.

For the first three years, the total budgets projected are:

	1970-1971	1971-1972	1972-1973
University Contribution	$ 37,954	$ 55,127	$ 56,487
Proposed Sponsorship	$110,000	$110,000	$100,000
Total Budget	$147,954	$165,127	$156,487
Request Under Step Funding	$110,000	$ 55,000	$ 25,000

Thus, the total funding requested initially is $190,000.

BUDGET SUMMARY

University of Minnesota
Applicant

$320,000
Grand Total ($)

1970 - 1973
Period of Grant

($) Approved by UMTA
(Leave Blank Until Approval)

Budget Category	Research			Training			Total		
	1st year	2nd year	3rd year	1st year	2nd year	3rd year	1st year	2nd year	3rd year
Faculty Salaries	7,047	13,863	9,064	8,683	-	-	15,730	13,863	9,064
Student Stipends	15,855	16,665	15,048	29,297	29,620	29,767	45,152	46,285	44,815
Tech-Clerical Salaries&Wages	1,145	275	200	8,550	9,135	9,592	9,695	9,410	9,792
Supplies and Materials	1,836	1,250	1,249	3,350	2,300	1,500	5,186	3,550	2,749
Equipment and Services	1.384	2,174	2,500	3,975	2,625	2.425	5,359	4,799	4,925
Travel	1,811	2,000	2,000	1,200	975	975	3,011	2,975	2,975
Fringe Benefits	938	1,549	1.044	1,217	689	716	2,155	2,238	1,760
Publication Costs	-	-	-	-	-	-	-	-	-
Indirect Costs	10,484	13,560	10,600	13,228	13,320	13,320	23,712	26,880	23,920
Totals by Year	40,500	51,336	41,705	69,500	58,664	58,295	110,000	110,000	100,000

BUDGET FOR PROJECT BA

Description	1970 - 71		1971 - 72		1972 - 73	
	U of M Contribution	Proposed Sponsorship	U of M Contribution	Proposed Sponsorship	U of M Contribution	Proposed Sponsorship
Senior Staff (F. Beier) 1/4 time 3 months	1100					
1/4 time 3 months		1100				
Secretary 1/4 month		125				
Supplies		20				
Computer Expense**	CP 5	81				
	PP 9					
Health Plan	10	13				
Fringe Benefits	116	127				
Overhead	480	534				
TOTAL	1706	2000				

**Computer Expense: Minutes of computer time @$14; PP= Minutes of peripheral equipment @ $1.25

BUDGET FOR PROJECT CE

Description	1970 - 71		1971 - 72		1972 - 73	
	U of M Contribution	Proposed Sponsorship	U of M Contribution	Proposed Sponsorship	U of M Contribution	Proposed Sponsorship
Senior Staff (M.J. Huber) 1/4 time 9 months	4200		4410		4640	
Full time, 2 months (Summer)	----	----		3920		4064
Research Assistant 1/2 time 9 months Full time 2 months		4000		4200		4410
Materials & Supplies		256		300		300
Travel*		250		250		250
Computer Costs**		16CP 21PP 250		32 CP 42 PP 500		32 CP 42 PP 500
Health Plan	123	----	123	27	123	27
Fringe Benefits	441	----	463	412	487	427
Overhead	1831	1744	1923	3671	2023	3695
TOTAL	6595	6500	6919	13,280	7273	13,673

*Basis of Travel: One trip per year to Washington, D.C.: Air Fare $126, 5 days hotel @ $15; meals @ $8.50 ground transportation $6.50

**Computer Costs: CP = Minutes of computer time @ $14; PP = Minutes of peripheral equipment @ $1.25

BUDGET FOR PROJECT ECON

Description	1970 - 71		1971 - 72	1972 - 73
	U of M Contribution	Proposed Sponsorship	U of M Contribution	Proposed Sponsorship
Senior Staff 1/4 time, 9 months	4436			
Full time, (Summer) 1 mo. 1970; 2 mo. 1971		1878		3943
Research Assistant 1/2 time 9 months Full time 3 months		4000		
Full time 3 months (Summer, 1971)				1000
Computer Time**		CP 22 PP 36 353	CP 12 PP 38	215
Fringe Benefits	466	193		360
Health Plan	30	13		27
Overhead	1934	2563		2155
TOTAL	6866	9000		7700

**Computer Time: CP = Minutes of computer time @ $14; PP = Minutes of peripheral equipment @ $1.25

BUDGET FOR PROJECT EE

Description	1970 - 71		1971 - 72		1972 - 73	
	U of M Contribution	Proposed Sponsorhsip	U of M Contribution	Proposed Sponsorship	U of M Contribution	Proposed Sponsorship
Senior Staff (K.S.P. Kumar) 10%, 9 months	1651					
Full time, 3 months (Summer)		3225				
Travel*		500				
Supplies		503				
Computer Expense**	32 CP 42 PP	500				
Health Plan	12	27				
Fringe Benefits	173	339				
Overhead	720	1406				
TOTAL	2556	6500				

*Basis for travel: One trip to Washington, D. C.: Air fare $126; 5 days hotel @ $15; meals @ $8.50; ground transportation $6.50.

**Computer Expense: CP + Minutes of Computer time @ $14; PP + Minutes of peripheral equipment @ $1.25.

BUDGET FOR PROJECT GEOG

Description	1970 - 1971		1971 - 1972		1972 - 1973	
	U of M Contribution	Proposed Sponsorship	U of M Contribution	Proposed Sponsorship	U of M Contribution	Proposed Sponsorship
Senior Staff (R.B. Adams) 1/5 time, 9 months 1/2 time, 2 months	4900		5145		5402	
Research Assistant 1/2 time, 9 months		3300		3465		3638
Travel*		561		250		250
Supplies (including maps)		1000		50		50
Computer Expense**	CP 12 PP 26	200	CP 30 PP 64	500	CP 30 PP 64	500
Health Plan	38	----	38	----	38	----
Fringe Benefits	515	----	540	----	567	----
Overhead	2136	1439	2243	1151	2355	1586
TOTAL	7589	6500	7966	5766	8362	6024

*Basis of travel: One trip to Washington, D.C. each year; 5 days hotel @ $15; meals @ $8.50; ground transportation $6.50 = $250.

**Computer Expense: CP = minutes of computer @ $14; PP = minutes of peripheral equipment @ $1.25.

BUDGET FOR PROJECT ME 1

Description	1970 - 71		1971 - 72		1972 - 73	
	U of M Contribution	Proposed Sponsorship	U of M Contribution	Proposed Sponsorship	U of M Contribution	Proposed Sponsorship
Senior Staff (D. Frohrib)						
1/4 time 6 months	1686					
1/4 time 2 months		844				
Research Ass't						
1/4 time 9 months		1455				
Secretary						
1/8 time		587				
Supplies		37				
Travel*		250				
Computer Expense**						
Fringe Benefits	177	144				
Health Plan	20	27				
Overhead	735	1258				
TOTAL	2618	4602				

*Basis of Travel: One trip to Washinton D.C. to technical meeting - Fare $126, 5 days; Hotel @ $15, Meals @ $8.50 ground transportation $6.50

**Computer Expense: CP=minutes of computer @$14, PP=Minutes of peripheral equipment @ $1.25

BUDGET FOR PROJECT ME-2

Description	1970 - 71		1971 - 72		1972 - 73	
	U of M Contribution	Proposed Sponsored	U of M Contribution	Proposed Sponsorship	U of M Contribution	Proposed Sponsorship
Senior Staff (J. E. Anderson) 1/4 time 9 months	3950					
Research Ass't 1/2 time 9 months		3100				
Secretary		433				
Supplies		20				
Computer Expense**						
Travel*		250				
Fringe Benefits	41	40				
Health Plan	30	15				
Overhead	172	1540				
TOTAL	4193	5398				

* Basis of travel: One trip to Washington D. C.- Fare $126, 5 days, Hotel @ $15, Meals @ $8.50, Ground transportation $6.50

**Computer Expense: CP=Minutes of computer @ $14, PP= Minutes of peripheral equipment @$1.25

EXPECTED PROJECTS (ESTIMATES)

Description	1970 - 71		1971 - 72		1972 - 73	
	U of M Contribution	Proposed Sponsorship	U of M Contribution	Proposed Sponsorship	U of M Contribution	Proposed Sponsorship
Staff				6000		5000
Research Ass't				8000		7000
Fringe Benefits & Health Plan				723		590
Overhead				6223		5319
Clerical & Technical				275		200
Materials				900		899
Computer				959		1500
Travel				1500		1500
TOTAL			28,000	24,580	28,000	22,008

SEMINAR & WORKSHIP

Description	1970 - 71		1971 - 72		1972 - 73	
	U of M Contribution	Proposed Sponsorship	U of M Contribution	Proposed Sponsorship	U of M Contribution	Proposed Sponsorship
Senior Staff (to be designated)						
4 @ 1/4 time, 3 months For Workshop		3433*				
Honoraria for Seminar		2000		1000		1000
Materials		200		200		200
Total		5633		1200		1200

*The actual amount is estimated as $6933. Partial funding is sought from another source.

PROGRAM COORDINATION

Description	1970 - 71		1971 - 72		1972 - 73	
	U of M Contribution	Proposed Sponsorship	U of M Contribution	Proposed Sponsorship	U of M Contribution	Proposed Sponsorship
Coordinator (D.L. Gerlough) 1/4 time, 9 months 1/4 time, 9 months	5250	5250	11,025		11,576	
Secretary Full time, 10 months		4500		12 months 5670		12 months 5954
Adm. Ass't Full time, 1 1/2 months		750				
Fringe Benefits	551	1039	1,156	527	1.215	554
Health Plan	30	178	61	162	61	162
Reproduction Services		500		500		500
Supplies		500		500		500
Travel*		750		750		750
Total	5831	13,467	12,242	8,109	12,852	8420

*Basis of travel: 3 trips to Washington, D. C. @ $250. (Fare $126, 5 days Hotel @ $15, Meals @ $8.50, ground transportation @ $6.50)

SUMMARY OF RESEARCH BUDGET COMPONENT

Description	1970 - 71		1971 - 72		1972 - 73	
	U of M Contribution	Proposed Sponsorship	U of M Contribution	Proposed Sponsorship	U of M Contribution	Proposed Sponsorship
Project BA	1706	2000				
Project CE	6595	6500	6919	13,280	7273	13,673
Project Econ	6866	9000		7,700		
Project EE	2556	6500				
Project Geog	7589	6500	7966	5,776	8362	6,024
Project ME 1	2618	4602				
Project ME 2	4193	5398				
Expected New Proj.			28,000	24,580	28,000	22,008
TOTAL	32,123	40,500	42,885	51,336	43,635	41,705

SUMMARY OF BUDGET FOR TRAINING COMPONENT

Description	1970 - 71		1971 - 72		1972 - 73	
	U of M Contribution	Proposed Sponsorship	U of M Contribution	Proposed Sponsorship	U of M Contribution	Proposed Sponsorship
Fellowship **		39,725		40,000		40,000
Library		10,675		9,355		8,675
Seminar		2,200		1,200		1,200
Workshop	*	3,433				
Coordination	5,831	13,467	12,242	8,109	12,852	8,420
TOTAL	5,831	69,500	12,242	58,664	12,852	58,295

*Contribution of $3500 for workshop being sought from another source.

**The item for fellowships includes the University of Minnesota "Cost of education" in the amount of $2500 per student. This covers tuition fees, and indirect charges.

APPENDIX A

SUMMARY OF FELLOWSHIPS AWARDED FOR ACADEMIC YEAR 1969-70

Name	Major Department	Degree Sought	Type of Fellowship
Aydinalp, T. M.	Civil Engineering (Transportation Planning)	Ph.D	Returnee from Professional Practice
Lamont, G. B.	Electrical Engineering (Dissertation on Transportation Problem)	Ph.D	Dissertation support
Meyer, R. O.	Public Administration (Transportation Planning)	M.A	Recent B.A.
Navin, F P. D.	Civil Engineering (Transportation Planning)	Ph.D	Holder of M.S. degree
Peyrebrune, H. L.	Civil Engineering (Transportation Planning)	Ph.D	Returnee from Professional Practice
Tomisak, R. A.	Mechanical Engineering (Dissertation on Transportation Problem)	Ph.D	Dissertation support

RESEARCH ASSISTANTSHIPS DURING 1969-70

Name	Department	Term of Assignment
Marvin Kraus	Economics	Summer, 1969
James Likens	Economics	Summer, 1969
Gerald Olafson	Mechanical Engineering	Summer, 1969
Thomas Pinfold	Economics	Summer, 1969
Gregory Stein	Geography	Sept. 15, 1969-June 15, 1970
Robert Tomisak	Mechanical Engineering	Summer, 1969
Ludo Verhavert	Mechanical Engineering	Sept. 15, 1969-June 15, 1970
Myrna Wooders	Economics	Sept. 15, 1969-June 15, 1970

APPENDIX B

SEMINAR IN URBAN TRANSPORTATION

Schedules for Fall and Winter Quarters, 1969 - 70

Date	Subject and Speaker(s)
Sept. 30	Introduction A. Characteristics of Urban transportation systems B. Need for interdisciplinary approaches to urban transportation problems C. Conduct of the seminar Dr. D. L. Gerlough University of Minnesota
Oct. 7	Geographic considerations in Urban Transportation System Planning and Design Dr. J. R. Borchert Dr. R. B. Adams University of Minnesota
Oct. 10	Economic Aspects of Urban Transportation Systems Dr. H. Mohring University of Minnesota
Oct. 21	Psychological and Physiological Phenomena related to Urban Transportation Systems Dr. S. F. Hulbert U. C. L. A.
Oct. 28	Review of current Transportation Planning Procedures Dr. M. J. Huber University of Minnesota
Nov. 4	Political - Legal Aspects of Urban Transportation Systems Dr. M. E. Long University of Illinois

Nov. 11 Esthetic Considerations in Transportation System Design

Dr. M. J. Huber, U of M (Civil Eng.)
Dr. H. Iskander, U of M (Arch.)
Mr. C. E. Burrill, Minn. Dept. of Highways
Mr. Wei Ming Lu, City of Minneapolis
(Dept. of Planning)

Nov. 18 Sociological Aspects of Urban Transportation Systems

Dr. R. Smock
University of Michigan
(Dearborn Campus)

Nov. 25 Further Aspects of Transportation Planning

Mr. H. L. Peyrebrune
Urban Transportation Fellow
University of Minnesota

Dec. 2 Fare Setting Philosphies and Practices in Urban Transportation

Dr. D. Harper
Dr. N. A. Glaskowsky, Jr.
University of Minnesota

Jan. 6 Degisn of Pedestrian Facilities

Mr. F. P. D. Navin
Urban Transportation Fellow
University of Minnesota

Jan. 20 Control and Estimation Problems in Vehicular Traffic

Dr. K. S. P. Kumar
Mr. G. B. Lamont
Urban Transportation Fellow
University of Minnesota

Jan. 27 Recent Urban Transportation Research in Great Britian

Mr. T. M. Coburn
Road Research Laboratory
Ministry of Transport, U. K.

Feb. 3 — New Transportation Technologies

Dr. J. E. Anderson
University of Minnesota

Feb. 10 — Vertical Urban Transportation: Elevators for the World's Tallest Buildings

Mr. James J. Browne
Port of New York Authority

Feb. 17 — The Design Team Concept

Mr. Milton Pikarsky
Commissioner of Public Works
City of Chicago

Feb. 24 — Transit for the Twin Cities

Mr. Thomas B. Deen
Alan M. Voorhees and Associates, Inc.

Mar. 3 — Models of Transportation and Land Use

Mr. Morton Schneider
Creighton, Hamburg, Inc.

Mar. 10 — Congestion and the Near-Far Problem in Airport Pricing

Mr. James Likens
Pomona College
(Formerly Research Assistant
Program in Urban Transportation
University of Minnesota)

SEMINAR ATTENDANCE

	Average Attendance Per Session*
Graduate Students	13.3
Faculty	5.4
Minnesota Highway Department	5.0
U. S. Bureau of Public Roads	0.9
Other Agencies	0.4
Undergraduate Students	1.0
Industry, consultants, etc.	0.5
	26.5

*September 30, 1969 - March 3, 1970

APPENDIX C

METROPOLITAN COUNCIL
Suite 101, Capitol Square Building, Saint Paul, Minnesota 55101
227-9421

MEMORANDUM

September 24, 1969

TO: John Borchert

FROM: Don Carroll

SUBJECT: Possible Transportation Study Subjects

The following list of transportation problem areas, possibly useful for determining research and /or teaching emphasis, may be of value to the transportation program:

1. Freeway impact -- land use change on freeway expressway system. Major land use change has occurred on Twin Cities system over the past ten years. Major sub-regional concentrations of economic activity are occurring. What are the changes? Types of economic activity? land use types? Trip generation and system implications?
2. Major urban structure manifestations of freeway-expressway construction; investigation of formation of major high intensity nodes in suburban areas and function of region-wide accessibility in such formation.
3. Generalized total cost-benefit methods; the so-called "non-quantifiable" costs and benefits related to building (or not building) transport routes.
4. Standards; Route spacing; Interchange location and spacing; freeway-arterial mix.
5. Traffic models -- Generation through assignment.
6. Land use models -- migration models
7. Functional classification methods; funding by jurisdiction.
8. Model designs for access to various land use activities under various system conditions.
9. Weekend travel - magnitude, forecasts, fringe build-up, camper-trailers and their effect on capacity.
10. Population structure -- aggregate and locational forecasting for family size, age structure, income. Implications of family size, age structure and income on trip generation and general mobility needs.
11. General work - leisure relationships and implications for transportation.
12. System evaluation, based on transportation (mobility) criteria.
13. System evaluation, based on non-transportation criteria.
14. Priority determination and construction programming methods.

15. Transportation planning methods for small urban areas; a need exists for an "in-between" approach, between full, comprehensive study and the simple external survey approach, for towns of, say, 20-50,000.

16. Statewide Planning
    a. functional classification methods.
    b. system evaluation
    c. funding
    d. priority determination methods
    e. forecasting models

17. Modal split

18. System and Program Management.

19. Comparative Study - Montreal, Cleveland, Toronto, Chicago, Atlanta, San Francisco, Twin Cities -- urban structure, densities, population composition, incomes, general level of urban decentralization -- as related to types of highway and transit systems in those cities -- other cities of course could be added.

DC:tv
9.24.69

APPENDIX D

STATE OF MINNESOTA
DEPARTMENT OF HIGHWAYS
ST. PAUL, MINN. 55101

March 4, 1970

Dr. Daniel Gerlough
Associate Professor
Department of Civil Engineering
University of Minnesota
Minneapolis, Minnesota 55455

Dear Professor Gerlough:

Since talking with you today, I have visited with those from the Highway Department who have attended the seminars in Urban Transportation offered by the University of Minnesota.

They have volunteered that the individual sessions have been very worth while on a single purpose understanding of the lecturer's presentation. More important however, to them, to me and to those of us involved in transportation planning in this Metropolitan Area is the better total understanding that we have, because of the course, for transportation planning. It has helped us achieve a much broader base from which to do our work.

We would suggest the course be continued. We think it could address itself, in addition to technology, to the environmental concepts of transportation planning. And as a suggestion a workshop session or two might prove of value to the course participants.

Sincerely,

C. E. Burrill
Assistant Commissioner -
Transportation & Transit
Planning & Programming

March 9, 1970

ASSURANCE OF COMPLIANCE WITH
TITLE VI OF THE CIVIL RIGHTS
ACT OF 1964 (DEPARTMENT OF TRANSPORTATION)

UNIVERSITY OF MINNESOTA
(Name of Recipient or Applicant)
(hereinafter called the "Recipient")

HEREBY AGREES THAT it will comply with Title VI of the Civil Rights Act of 1964 (P.L. 88-352) and all requirements imposed by the U.S. Department of Transportation, to the end that, in accordance with Title VI of that Act, no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity for which the Recipient receives Federal financial assistance from the Department under Federal urban mass transportation programs; and HEREBY GIVES ASSURANCE THAT it will immediately take any measures necessary to effectuate this agreement.

If any real property or structure thereon is provided or improved with the aid of Federal financial assistance extended to the Recipient by the Department under Federal urban mass transportation programs, this assurance shall obligate the Recipient, or in the case of any transfer of such property, any transferee, for the period during which the real property or structure is used for a purpose for which the Federal financial assistance is extended or for another purpose involving the provision of similar services or benefits. If any personal property is so provided, this assurance shall obligate the Recipient for the period during which it retains ownership or possession of the property. In all other cases, this assurance shall obligate the recipient for the period during which the Federal financial assistance is extended to it by the Department under Federal urban mass transportation programs.

THIS ASSURANCE is given in consideration of and for the purpose of obtaining any and all Federal grants, loans, contracts, property, discounts or other Fereal financial assistance extended after the date hereof to the Recipient by the Department under Federal financial assistance will be extended in reliance on the representations and agreements made in this assurance, and that the United States shall have the right to seek judicial enforcement of this assurance. This assurance is binding on the Recipient, its successors, transferees, and assignees. The person or persons whose signatures appear below are authorized to sign this assurance on behalf of the Recipient.

Dated March 9, 1970

University of Minnesota
(Recipient)

BY [signature]
(President, Chairman of Board, or comparable authorized official)

Minneapolis, Minnesota
55455
(Recipient's mailing address)

Opinion of Counsel

University of Minnesota Board of Regents

Re: Proposal for a Federal Grant submitted to the Department of Transportation Research and Training in Urban Transportation Program - University of Minnesota

Opinion of Counsel

That the applicant, University of Minnesota Board of Regents, a body corporate of the State of Minnesota, with jurisdiction over the University of Minnesota, has the authority under its general powers to establish a research and training program in urban transportation, and to accept a Federal grant for its operation.

Statement of Counsel

That C. S. Plank, Controller, is authorized to execute contracts approved by the University of Minnesota Board of Regents, affecting the University of Minnesota and to accept funds for the Federal Government upon its behalf for the use of that institution.

S. B. Garrison
Assistant Secretary
Regents of the University of Minnesota

March 9, 1970